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EVALUATION OF AIR POLLUTION IN THE STATE OF WASHINGTON

E. R. Hendrickson, et al

Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

December 1956

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EVALUATION OF AIR POLLUTION STATE OF WASHINGTON

WASHINGTON STATE DEPARTMENT OF HEALTH

and

U.S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE

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EVALUATION OF AIR POLLUTION
IN THE
STATE OF WASHINGTON

REPORT OF COOPERATIVE SURVEY MADE
JULY 1 THROUGH NOVEMBER 30, 1956

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
and
STATE OF WASHINGTON DEPARTMENT OF HEALTH

ROBERT A. TAFT SANITARY ENGINEERING CENTER
CINCINNATI, OHIO

December 1956

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The Gas Industries Association

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State Agencies

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SUMMARY AND CONCLUSIONS

Air pollution problems do exist in the State of Washington. The majority of present problems are localized and of limited severity. Continued rapid growth of some areas, in the absence of adequate control measures, could create more intense future community or regional problems.

Meteorological factors appear to be more conducive to the development of air pollution in eastern Washington; however, there is a greater concentration of population and potential air pollution producing activity in western Washington. In the Puget Sound basin, particularly at Seattle and Tacoma, air pollution contributes to many days of reduced visibility. Air stagnation occurs with sufficient frequency that the uncontrolled emission of pollutants accompanied by rapid growth cannot go unheeded.

A number of the communities which were visited offered the appearance of "general dirtiness" caused by soot and flyash. Such conditions accompany poor combustion and can be readily controlled.

In several areas of the State, agriculture has experienced some damage from air-borne effluents. As the causes have been identified, control measures have alleviated many of these problems. Agriculture has also contributed to air pollution. Crop spraying and cultivation practices have created some problems in the past, but modern methods are helping to eliminate these as sources of pollution.

Automobiles, because of the numbers involved, are the major contributor of pollutants by transportation activities. In all Washington communities studied, other transportation sources contributed a minor load. Steam locomotives, creating localized problems in a few areas, are rapidly being eliminated. Marine vessels cause localized problems at times, but the total contribution is small.

The combustion of fuel for heating households and commercial buildings makes an appreciable contribution to the mass of polluted air during the heating season. The relative severity of this contribution as a dirtiness factor is a function of the predominant type of fuel and local firing practices.

The effect and proportion of the industrial contribution to the total air pollution load in communities over the State varies from a relatively insignificant factor to instances in which it is a major contribution. Industrial emissions may be a nuisance or contain irritants, or have a toxic effect or cause economic damage. Many of the industries of Washington have taken a progressive attitude toward air pollution control and have made substantial investments in control equipment. Others, for various reasons, have done little abatement.

Many communities have been hesitant to take active control steps in their own domain. In numerous areas visited by the survey team, the most serious air pollution problems included city or county burning dumps and poor combustion practices in public buildings. Several cities, however, have official or semi-official planning or air pollution control boards who are considering the problem. Tacoma has the only active air pollution control program in the State.

There are several sources of pollution outside the State which at times affect Washington citizens.

In order for the State to experience continued progressive development, industry, agriculture and community activities must exist amicably side by side and find solutions for their mutual problems. In air pollution technology, engineering controls are available for many problems, yet many factors remain as yet unexplored. There is at present no economical solution for some of the problems which exist here. There is a great need for continued, coordinated study and investigation of the air pollution problems in Washington. Such effort will not only help solve these problems, but will also make essential contributions to the general fund of air pollution knowledge.

RECOMMENDATIONS

On the basis of knowledge now available about the growing problem of polluted air, and on the basis of the findings of this state-wide survey, it is recommended that:

1. Air pollution be recognized as a matter of State concern.
2. Ways and means of prevention and control of air pollution, including consideration of local and regional aspects, be investigated.
3. A continuing State program include surveillance, study and cooperation, by providing for:
    a. Technical assistance and consultation for local or regional air pollution control activities.
    b. Surveillance and investigation of the effects of air pollution on health, plant and animal life, materials, and weather.
    c. Sampling of the ambient air in order that a surveillance of the pollution levels may be maintained.
    d. Study of climatological and meteorological factors as related to local and regional air pollution.
    e. A current inventory of air pollution sources.
    f. Collection and dissemination of information on effects and methods of control of air pollution, both for technical application and for advice to the general public.
    g. Initiation and support of research on air pollution.
    h. Adequate laboratory services to support these activities.
4. An agency be designated to represent the State in interstate and Federal air pollution matters.

1.A

SECTION ONE

PART I

INTRODUCTION

Authority for Survey

Purpose and Scope

Methodology

General Discussion of Air Pollution

Previous Studies

PART I
INTRODUCTION

AUTHORITY FOR SURVEY

The 84th Congress, by Public Law 159, made available support for air pollution research, training, demonstration projects and technical assistance to states and their subdivisions through a program administered by the Public Health Service.

Representatives of several of the major cities and public groups in Washington requested that a state-wide air pollution study be made under this program. Governor Arthur B. Langlie placed the responsibility for air pollution activities in the State Department of Health. Negotiations for assistance to the State Department of Health by the Public Health Service for such a survey were completed in May 1956. Participation by the State was supported by appropriation from the Governor's emergency fund.

PURPOSE AND SCOPE

The objective of this study was to investigate the status of air pollution in Washington and to supply, insofar as possible, data from which the need and scope of future air pollution program activity on a state or local basis could be determined.

The scope of the study was to assess the present and potential state problem and to delineate specific problem areas, present and future, through a study of population distribution and trends, geography and topography, meteorology and climatology, and existing and potential sources of pollution. In addition, a determination was made of available resources in the State for research and investigation in air pollution problems. The sources of pollution which are considered include transportation, domestic activities, agricultural practices, industrial activities, refuse disposal, out-of-state sources, and natural sources.

METHODOLOGY

The information used in preparing this report was obtained through:

(1) Questionnaires

(2) Interviews with informed individuals - public and private

(3) Direct observation

(4) Review of existing data

The study was initiated by meetings, at which the aims and scope of the study were outlined, with official and unofficial organizations in the State interested in air pollution. In every instance, wholehearted cooperation was obtained.

Although the limitations of securing information by questionnaire are well recognized, questionnaires were prepared to provide a starting point for the study. In addition, a form was developed for use during field surveys and interviews (Appendix).

The questionnaires were designed to show the survey personnel where air pollution problems exist, and were used as a guide for planning field visits. No statistical analysis was made of any of the returns. Of the 742 questionnaires mailed, 47 per cent of those to industry, 33 per cent of those to city officials, and 62 per cent of those to local health officers were returned. The returns from industry provided informative data on air pollution controls in use or planned.

Field visits were made to all cities of over 10,000 population; and to all other communities where the questionnaire return indicated a specific air pollution problem. The resulting coverage was as follows:

Population	Number of Cities in State	Number of Cities Visited	Per cent Visited
Over 10,000	23	23	100
4,000 - 10,000	22	15	68
2,500 - 4,000	23	12	52
1,000 - 2,500	56	12	22
Under 1,000	128	11	9
Total	252	73	29

The communities visited contain more than 80 per cent of the urban population of the State. In each community visited, the topography was observed and described, meteorological data were obtained from existing records when available, and the various sources of pollution were determined and observed. Where information on previous air pollution studies was available, maximum use was made of these data.

GENERAL DISCUSSION OF AIR POLLUTION

Air pollution is the presence in the atmosphere of substances put there by the acts of man or nature, in concentrations sufficient to interfere with man's comfort, safety, or health, or with the full use and enjoyment of his property.

For any air pollution problem to exist, three conditions must occur simultaneously: a source of pollutants; a susceptible population or other receptor; and a mechanism for transport between the two.

The source may be any activity of man or nature which releases to the atmosphere any dust, fume, gas, mist, odor, smoke, or vapor. The population or receptor can be people, vegetation, domestic animals, homes, or manufacturing plants. Susceptibility of the population is measured in terms of health, economics, aesthetics, or toxicity, and in many instances is tempered by the concentration of the pollutant, the economic dependence of the community, and the ability to adjust to the status quo. For a problem to exist, source and susceptible population must be brought together by the common bond of transport which is controlled by topography and meteorology.

Experience indicates that frequently the decision on whether an air pollution problem actually exists is not based solely upon known or suspected adverse effects on health, comfort, safety, and economics. Public acceptance is many times the criterion for determining the need and degree of control. Nevertheless it is the responsibility of the official agencies to point out hazards, actual or potential, when such are not obvious to the public. For example, nuclear radiations are not detectable by the human senses, but their presence in the environment in sufficient amounts may constitute a very serious health problem.

Appraisal of the general environment to determine whether undesirable air pollution exists is difficult, since no simple index or criterion has yet been established. Community air pollution arises from the many activities of man, consequently such source factors as population density, industrial activity, modes of transportation, fuel usage practices, waste disposal practices, and other human activities individually and collectively play an important role. In addition, such natural features as meteorology and topography are important, since they can modify and intensify the accumulation of air-borne pollutants thus increasing their undesirable effects.

In the following sections the relative significance of these human and natural factors will be discussed in relation to the air pollution status, actual or potential, of the State of Washington.

PREVIOUS STUDIES

Previous studies of air pollution in Washington include:

One State-wide study in 1950(45)
Five community studies at
  Seattle in 1952(23)
  Spokane in 1951(28) and 1955(29)
  Tacoma in 1948(26)
  Longview in 1954(31)
Eight studies of special problems or problem areas within communities
  Seattle - North industrial area, 1950(24) and 1952(35)
  Everett - SO_2 damage from pulp mill, 1954(27)
  Spokane Pine blight by fluoride, 1952(30)
  Longview - Paint discoloration, 1954(32) and 1955(33)
  Ellensburg - Soot from a State institution 1955(35)
  Brewster - Smoke problem, 1954(39)
  Marysville - Dust from paving mix plant, 1954(40)
Four studies of fluoride effects on plants
  Ponderosa pine needles, 1955(41)
  Prune foliage, 1948(42)
  Gladiolus leaf scorch, 1950(43)
  Indicator plants, 1953(44)

Three theses (utilized in Seattle study)(23)

Seattle - Meteorological factors, 1952(36)

Seattle - Atmospheric fluorides, 1952(37)

Seattle - Evaluation of reflectance readings, 1952(38)

In addition, there were several privately supported studies the findings of which are confidential.

Whenever possible, use has been made of the results of these studies and they are discussed in the appropriate places in the text. For convenience they are listed as a group in the Bibliography with continuing reference numbers.

Most of these studies have been done by either the University of Washington through its Environmental Research Laboratory and its Department of Meteorology, or by the State College of Washington through its State Institute of Technology, Division of Industrial Research, its College of Veterinary Medicine, and its Agricultural Experiment Stations.

SECTION ONE

PART II

GENERAL STATE SITUATION

- Population
- Topography and Climatology
- Sources of Pollution
  - Fuel
  - Transportation
  - Industrial Activity
  - Agriculture
  - Refuse Disposal
- Out of State Sources
- Natural Sources
- Resources Available for Future Research or Investigation

PART II

GENERAL STATE SITUATION

POPULATION

The population of the State of Washington as reported in the 1950 Census was 2,378,963. Thus, Washington ranked 23rd among the 48 states. The post-censal estimate by the Washington State Census Board for 1956 was 2,651,900 and it predicts 3,171,000 by 1965 (Figure I(1)- The dividing line between east and west is the ridge of the Cascade Mountains.).

Factors contributing to the marked population growth since 1940 include(1):

1. The expansion of military bases on the West Coast and the wartime assignment to West Coast manufacturers of large contracts for ships, airplanes, materiel, and various types of equipment which brought a huge influx of workers from other parts of the nation.
2. The influx of workers attracted by employment resulting from the great backlog of demand for housing and consumer's goods, caused by deferment during World War II of construction and production for civilian use.
3. The sharp rise in birth rates, and continued decline in mortality both in the Nation and in this area.
4. The large and continuing increase in manufacturing facilities, such as airplane factories, shipyards, basic steel and light metals producing plants, and the atomic energy installation.

Washington's urban population was 1,493,146 in 1950 or 63.2 per cent of the total compared to 64.0 per cent nationally.

A CENTURY OF POPULATION GROWTH
STATE OF WASHINGTON: 1870 TO 1970

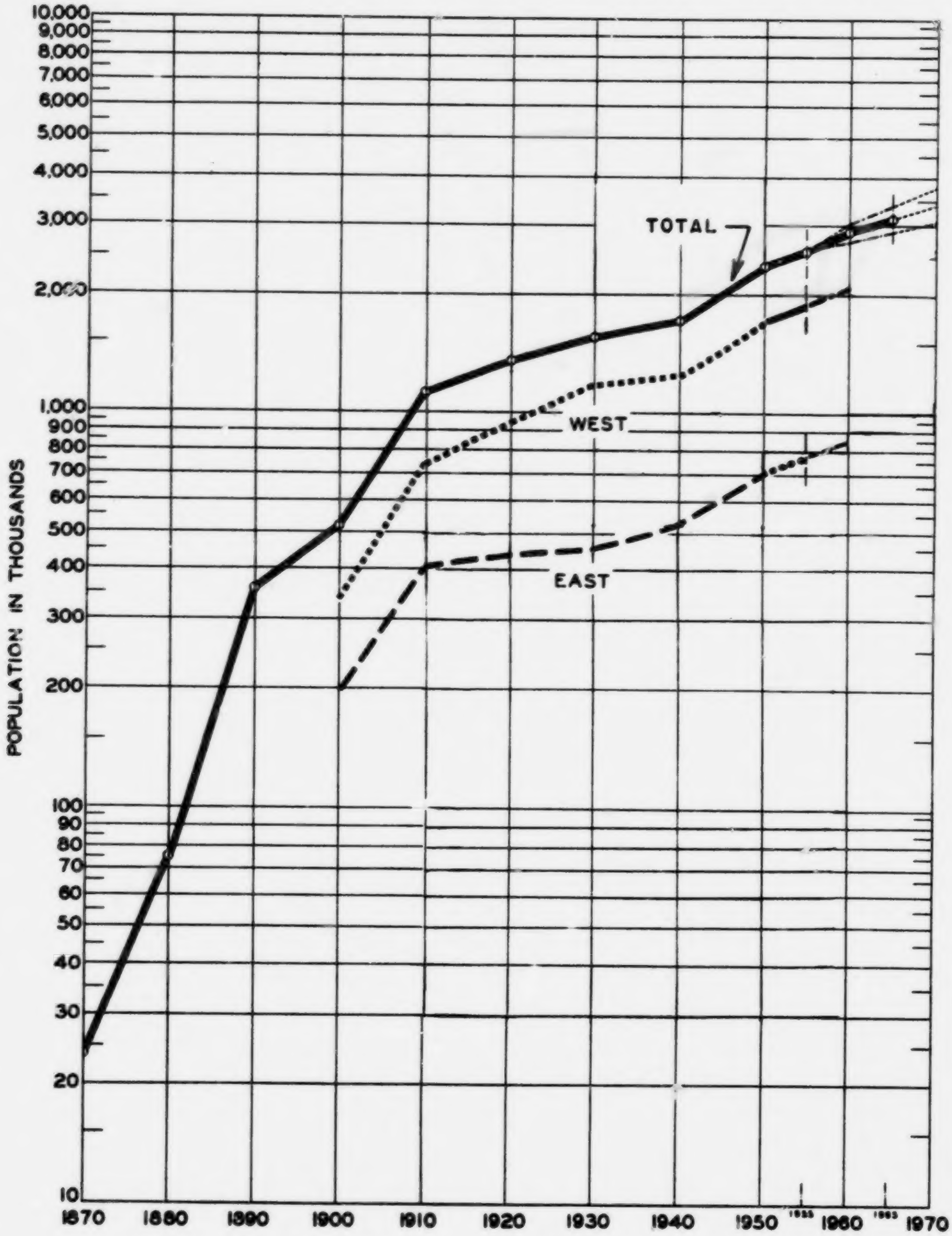


FIGURE I

With the exception of Spokane County in the east and Clark County in the southwest, the heaviest concentrations of population are in the counties bordering Puget Sound (Figure 2). These are King, Kitsap, Pierce, Thurston, and Snohomish Counties with respective population densities of 383.7, 200.8, 181.6, 66.4, and 63.5 persons per square mile based on 1956 estimates.

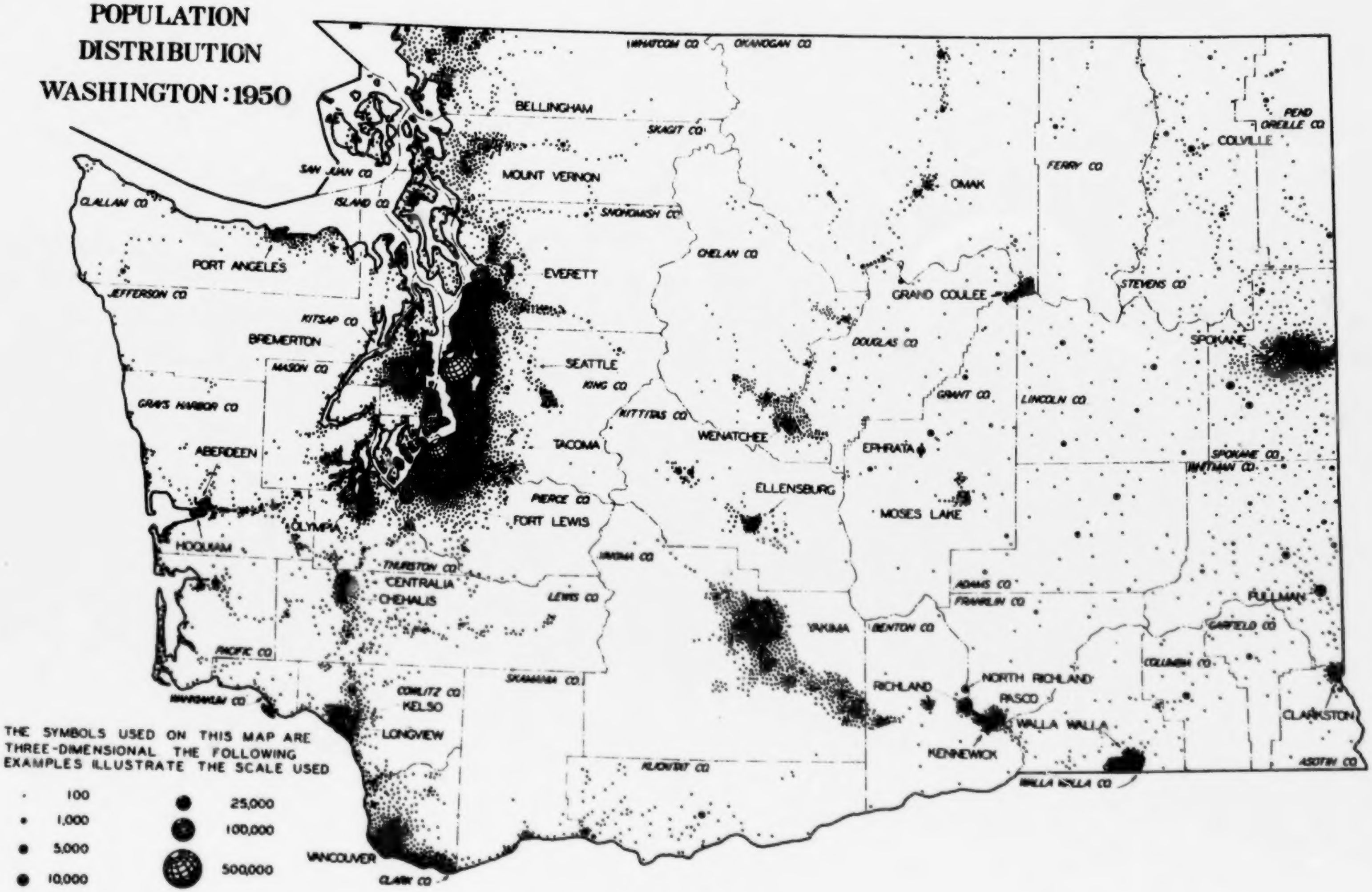
The cities over 20,000 and their respective counties with their populations and ranks are shown in the following table:

Population Pattern of Cities over 20,000

Rank*	City	Population		Rank*	County	Population	
		1950	1956			1950	1956
1	Seattle	467,591	562,500	1	King	732,992	818,700
2	Spokane	161,721	186,000	3	Spokane	221,561	265,100
3	Tacoma	143,673	156,700	2	Pierce	275,876	304,400
4	Yakima	38,486	44,300	4	Yakima	135,723	149,000
5	Vancouver	41,644	42,300	6	Clark	85,307	85,800
6	Bellingham	34,112	36,100	8	Whatcom	66,733	71,400
7	Everett	33,849	34,300	5	Snohomish	111,580	133,400
8	Bremerton	27,678	30,100	7	Kitsap	75,724	80,700
9	Richland**	21,809	26,200	9	Benton	51,370	67,200
10	Walla Walla	24,102	25,600	16	Walla Walla	40,135	42,100
11	Longview	20,339	23,100	10	Cowlitz	53,369	57,900
12	Aberdeen	19,653	20,500	11	Grays Harbor	53,644	56,400

* Rank shown according to 1956 population estimate

** Unincorporated



POPULATION DISTRIBUTION WASHINGTON : 1950

WHATCOM CO
OKANOGAN CO
BELLINGHAM
SKAGIT CO
PEND OREILLE CO
COLVILLE
SAN JUAN CO
MOUNT VERNON
FERRY CO
OMAK
CLALLAM CO
ISLAND CO
SNOHOMISH CO
PORT ANGELES
CHELAN CO
EVERETT
JEFFERSON CO
GRAND COULEE
STEVENS CO
KITSAP CO
BREMERTON
DOUGLAS CO
SPOKANE
MASON CO
SEATTLE
KING CO
GRANT CO
LINCOLN CO
GRAYS HARBOR CO
KITTITAS CO
WENATCHEE
ABERDEEN
TACOMA
EPHRATA
SPOKANE CO
WHITMAN CO
ELLENSBURG
PIERCE CO
FORT LEWIS
MOSES LAKE
OLYMPIA
HOQUIAM
YAKIMA CO
THURSTON CO
CENTRALIA
ADAMS CO
FRANKLIN CO
CHEHALIS
LEWIS CO
PULLMAN
YAKIMA
BENTON CO
GARFIELD CO
PACIFIC CO
NORTH RICHLAND
COLUMBIA CO
SKAMANIA CO
RICHLAND
PASCO
WAHKIAKUM CO
COWLITZ CO
KELSO
WALLA WALLA
CLARKSTON
LONGVIEW
KENNEWICK
KLICKITAT CO
ASOTIN CO
WALLA WALLA CO
VANCOUVER
CLARK CO
THE SYMBOLS USED ON THIS MAP ARE THREE-DIMENSIONAL THE FOLLOWING EXAMPLES ILLUSTRATE THE SCALE USED
100
1,000
5,000
10,000
25,000
100,000
500,000

FIGURE 2

It is evident from a review of the State population figures that there is an ever-increasing trend, which is expected to continue in the foreseeable future. This may be interpreted to mean that communities will grow in number and size. Of significance also is the growth of the larger metropolitan areas such as those in the Puget Sound area and Spokane.

Since the rate of pollution of the atmosphere is related to the degree of human activity, air pollution throughout the State and in urban areas in particular may assume greater significance as a future problem. However, small communities and sparsely settled rural areas may have severe air pollution problems resulting from local source emissions.

TOPOGRAPHY AND CLIMATOLOGY

Washington, in the northwestern corner of the United States, borders on the Pacific Ocean and extends eastward more than 350 miles. Its extreme northern boundary is the Canadian border at the 49th parallel of latitude and much of its southern boundary is the Columbia River. Its area is some 67,000 square miles with 2300 square miles of water surface.

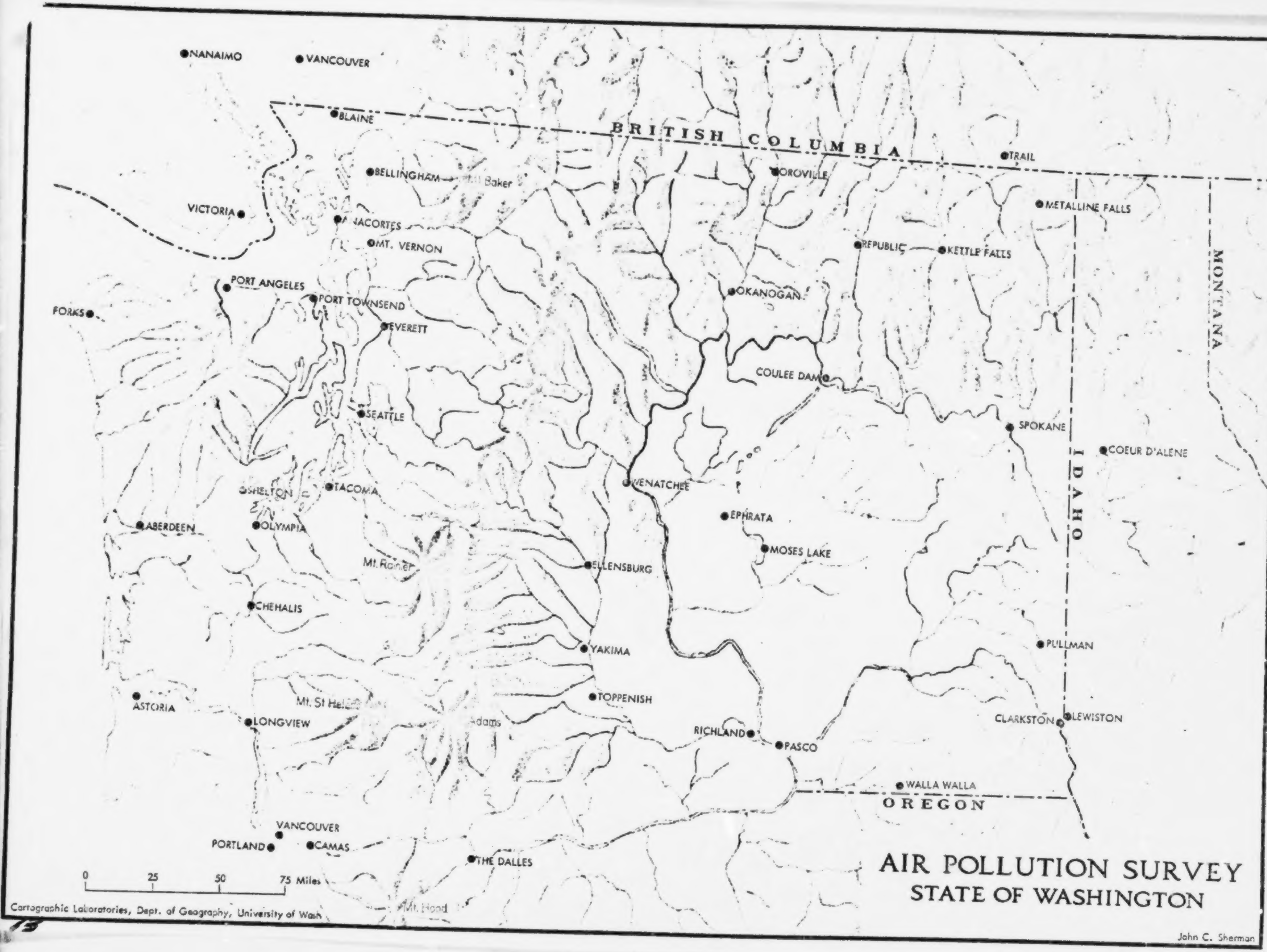
The topography of Washington (Map - Page 13) includes segments of several of the major topographical divisions characterizing the western margin of the North American Continent. They are as follows:

The Olympic Mountains - the highest of the comparatively low Coast Range which forms a rampart along the Pacific Ocean from Lower California to the islands of British Columbia and Alaska. They reach nearly 8000 feet and are one of the least accessible areas in the United States. The lower Willapa Hills to the south are also part of the Coast Range.

The Puget Sound Basin - a segment of the long, narrow trough which is more or less continuous from southern California to the Gulf of Georgia in British Columbia. Puget Sound begins at the eastern end of the Strait of Juan de Fuca (approximately 75 miles from the Pacific) and stretches for over 100 miles southward into the heart of western Washington. It provides deep-water shipping lanes leading to such ports as Seattle, Tacoma, Bellingham, Everett, and Olympia.

The Cascade Range - a subdivision of the mountain system which is practically continuous from Mexico to Alaska. The Range varies in width from about 60 miles at the Oregon line to about 100 miles at the British Columbia border, and it divides the State into two unequal parts: one-third of the area is on the west side and two-thirds is east of the Range. Several snow-capped peaks are from 10,000 to 12,000 feet high, while Mt. Rainier, the highest peak in the State, exceeds 14,000 feet. The irregular summit of the rugged Cascades is crossed by only a few readily accessible passes. Snoqualmie Pass, the main traveled route, is at 3000 feet elevation while others are at 4000 to 6000 feet.

The Columbia Basin - a semi-arid basin wherein lies most of the central and southeast area of the State and where elevations range from 1000 to 2000 feet. The Okanogan Highlands encroach from the north and the Blue Mountains border the Basin on the southeast. To the west are the foothills of the Cascades and to the east are the foothills of the Rockies -- the Selkirk Mountains and the Bitterroot Range. The Columbia River,



AIR POLLUTION SURVEY
STATE OF WASHINGTON

NANAIMO
VANCOUVER
BLAINE
BRITISH COLUMBIA
TRAIL
BELLINGHAM
Mt. Baker
OROVILLE
METALLINE FALLS
VICTORIA
ANACORTES
MT. VERNON
REPUBLIC
KETTLE FALLS
MONTANA
PORT ANGELES
PORT TOWNSEND
OKANOGAN
FORKS
EVERETT
COULEE DAM
SEATTLE
SPOKANE
IDAHO
COEUR D'ALENE
SHELTON
TACOMA
WENATCHEE
ABERDEEN
OLYMPIA
EPHRATA
MOSES LAKE
Mt. Rainier
ELLENSBURG
CHEHALIS
YAKIMA
PULLMAN
ASTORIA
Mt. St Helens
TOPPENISH
LONGVIEW
Adams
CLARKSTON
LEWISTON
RICHLAND
PASCO
WALLA WALLA
OREGON
VANCOUVER
PORTLAND
CAMAS
THE DALLES
0
25
50
75 Miles
Mt. Hood

Cartographic Laboratories, Dept. of Geography, University of Wash

John C. Sherman

second largest in the United States in annual runoff, drains the Basin through the only breach in the entire Pacific slope, the Columbia River Gorge. The north-central part of the Basin is characterized by spectacular dry coulees and canyons.

The Cascades are the dividing line between the two general climatological regions of the State:

West of the Cascades - the weather is strongly influenced by the proximity of the Pacific Ocean. During the winter, the prevailing wind is from the south to west quadrant. This brings warm moist air into the area with frequent overcast conditions or precipitation. Wind velocities during these periods are generally favorable for the dispersion of pollutants. The topography of the region is such that local winds may be entirely different from the general wind flow of the area.

Reportedly there are periods of atmospheric stagnation which may occur as frequently as six times during the winter and persist for several days at a time. Such periods often occur when cold air flows into the area from British Columbia and eastern Washington. Pollutants released in the area under these "fair weather" conditions may cause the most severe winter episodes.

In the summer, the prevailing wind direction is from the northwest to west quadrant. Here again, topography may radically affect the local wind situation. Westerly winds entering the region simultaneously through the Strait of Juan de Fuca and around the southern end of the Olympic Mountains may be deflected by local terrain; thus the westerly flow may be observed to be a northwest wind at Seattle and a south or southwest wind at Bellingham and Olympia. Toward evening the wind usually diminishes. Subsidence from the Pacific high often aids in the development of stable air conditions

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throughout the Puget Sound Basin during the night. Pollutants which accumulate during such periods are usually dispersed during the day.

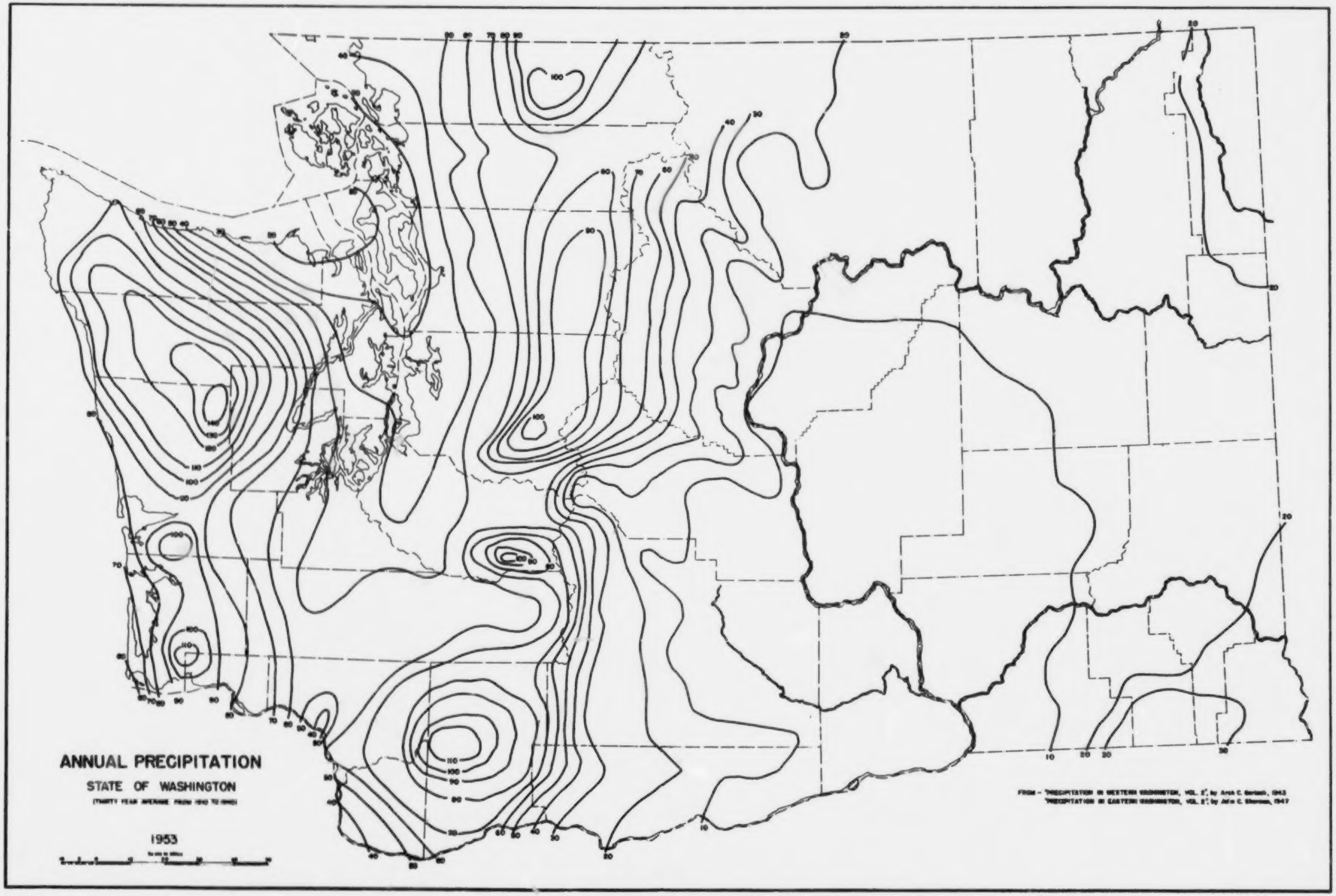
East of the Cascades - the climate is considerably different. Continental air masses flow into the "Inland Empire" with greater frequency than they do west of the Cascades. In the winter cold air frequently collects or forms in the bottom of the "bowl" of the Columbia Basin, while warm, moist air from the Pacific flows over it and often creates a cloud cover. Stable atmospheric conditions usually prevail for longer periods over this area than in western Washington; thus the air mass in the bowl may persist until a "Chinook" or a well-developed cold front replaces it.

It has been reported that September and October are the times of greatest stagnation while spring is the time of highest wind velocities.

In the summer, the prevailing wind is from the west over the mountains. The prevailing air mass is clear, dry, relatively warm, and occasionally unstable - particularly after June. However, during the nighttime, stable conditions are not infrequent. When air moves in from the south to southeast sector from the Gulf of Mexico, thunderstorms may result, but with little or no rain reaching the ground.

West of the Cascades, the dry season reaches its climax in July and August, after which the rainy season comes on gradually, reaching its peak in November, December, or January. East of the Cascades, the seasonal pattern is virtually the same, except during May and June, when the precipitation from shower activity increases to a well defined June peak. In many eastern areas, June is either the wettest or second wettest month of the year; however, July and August remain the two driest months (Figure 3).

Statistical analyses of meteorological data pertaining to the stability of the atmosphere in the State are not readily available. A review of five



ANNUAL PRECIPITATION

STATE OF WASHINGTON

(THIRTY YEAR AVERAGE FROM 1910 TO 1940)

1953

FROM - "PRECIPITATION IN WESTERN WASHINGTON, VOL. 2", by Arch C. Gerlach, 1943
"PRECIPITATION IN EASTERN WASHINGTON, VOL. 2", by John C. Sherman, 1947

Scale in Miles
100
140
110
100
90
80
70
60
50
40
30
20
10

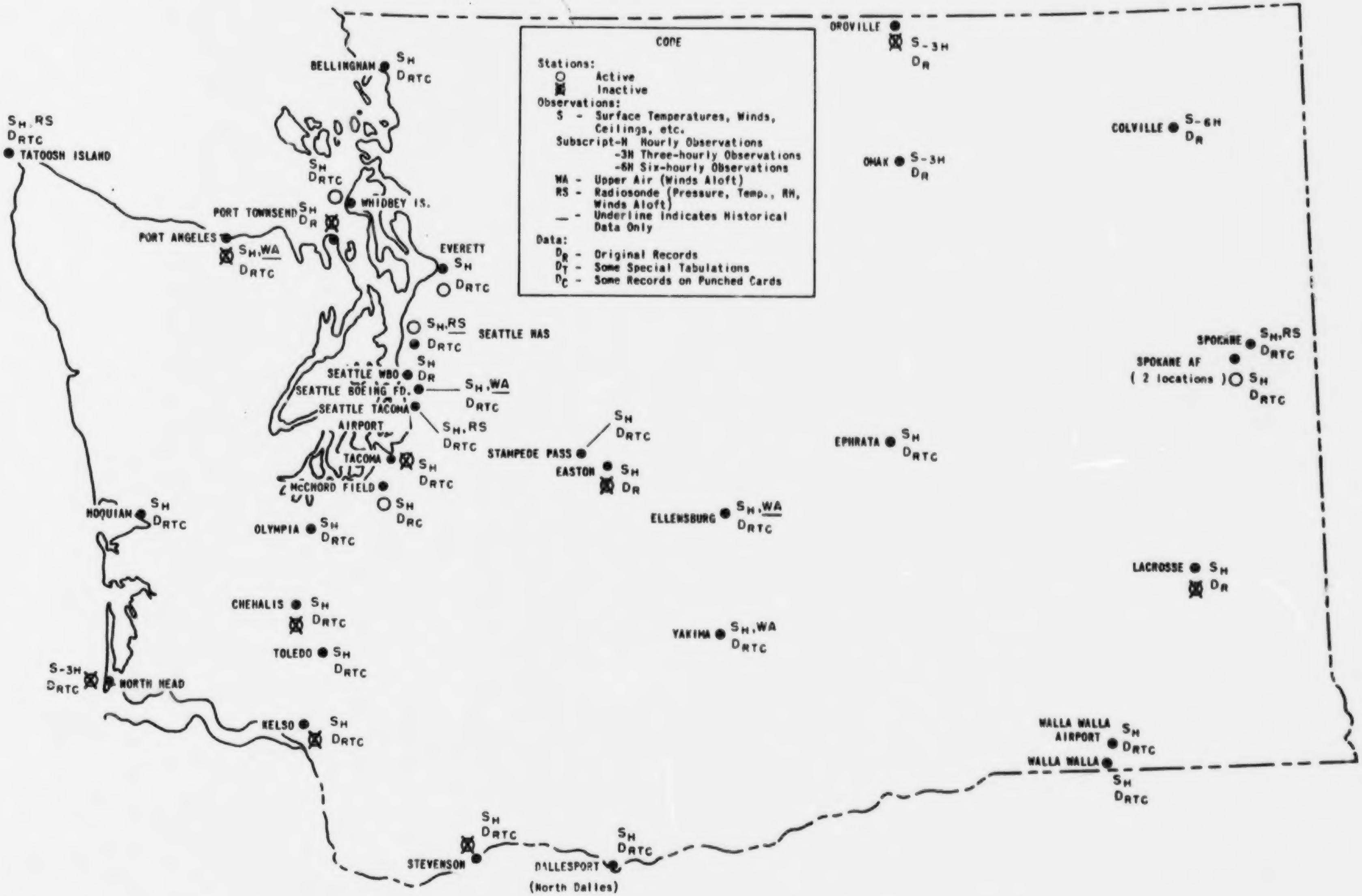
FIGURE 3

years of radiosonde data at Spokane has been made(28), as well as a study of an 11-month period of records from a 150-foot, special-measuring meteorological tower on the University of Washington campus(2). The latter study indicated that temperature inversions persisted for as long as two days on only two occasions at this low level.

Local climatology may vary from the general weather patterns described above due to local physical features. Information concerning these local factors and their effects are included, when pertinent, in the individual discussions of communities.

Meteorological stations in the State from which weather data are available are designated as either active or inactive (Figure 4). Only those inactive stations are shown from which a minimum of five years of historical records are available. The station network includes Weather Bureau, Civil Aeronautics Authority, Air Force, and Navy facilities. It should be noted that certain stations provide only 3-hourly and 6-hourly surface observations, and that three Weather Bureau stations in the State have facilities for upper air temperature measurements - Tatoosh Island, Seattle-Tacoma Airport and Spokane. Upper air soundings are also available from the Weather Bureau in Salem, Oregon - some 50 miles south of the State.

In summary, the topographical and climatological features of the State, though while differing considerably in eastern and western Washington, present a combination of natural conditions which at times are conducive to the (undesirable) accumulation of air pollutants. [In the western part the pertinent features are largely: moisture and fog, which develop near the Pacific Ocean and Puget Sound; peculiar wind regimes; and atmospheric stagnation, resulting from temperature inversions.]


CODE
Stations:
○ Active
☒ Inactive
Observations:
S - Surface Temperatures, Winds, Ceilings, etc.
Subscript-H Hourly Observations
-3H Three-hourly Observations
-6H Six-hourly Observations
WA - Upper Air (Winds Aloft)
RS - Radiosonde (Pressure, Temp., RH, Winds Aloft)
— - Underline Indicates Historical Data Only
Data:
D_R - Original Records
D_T - Some Special Tabulations
D_C - Some Records on Punched Cards
TATOOSH ISLAND S_H, RS D_{RTC}
BELLINGHAM S_H D_{RTC}
S_H D_{RTC}
WHIDBEY IS.
PORT TOWNSEND S_H D_R
PORT ANGELES S_H, WA D_{RTC}
EVERETT S_H D_{RTC}
S_H, RS D_{RTC} SEATTLE NAS
SEATTLE WBO S_H D_R
SEATTLE BOEING FD. S_H, WA D_{RTC}
SEATTLE TACOMA AIRPORT S_H, RS D_{RTC}
TACOMA S_H D_{RTC}
McCHORD FIELD S_H D_{RC}
STAMPEDE PASS S_H D_{RTC}
EASTON S_H D_R
HOQUIAM S_H D_{RTC}
OLYMPIA S_H D_{RTC}
CHEHALIS S_H D_{RTC}
TOLEDO S_H D_{RTC}
NORTH HEAD S-3H D_{RTC}
KELSO S_H D_{RTC}
STEVENSON S_H D_{RTC}
DALLESPORT (North Dalles) S_H D_{RTC}
ELLENSBURG S_H, WA D_{RTC}
YAKIMA S_H, WA D_{RTC}
OROVILLE S-3H D_R
OMAK S-3H D_R
EPHRATA S_H D_{RTC}
COLVILLE S-6H D_R
SPOKANE S_H, RS D_{RTC}
SPOKANE AF (2 locations) S_H D_{RTC}
LACROSSE S_H D_R
WALLA WALLA AIRPORT S_H D_{RTC}
WALLA WALLA S_H D_{RTC}

METEOROLOGICAL DATA SOURCES
STATE OF WASHINGTON
FIGURE 4

East of the Cascades, air pollution is aggravated by the frequent occurrence of stable atmospheric conditions of longer duration.

SOURCES OF POLLUTION

FUEL

Combustion produces considerable quantities of atmospheric pollutants in the form of gases and solid and liquid particulates. The burning of fuels for heat and power is, consequently, an important consideration in evaluating principal sources of air pollution.

This section of the report includes figures on the relative amounts of coal, petroleum, natural and manufactured gas, and wood consumed in residential, commercial, and industrial applications.

Data concerning fuel usage is based on the period prior to the advent of natural gas. Natural gas is expected to have a substantial effect on the future fuel use pattern.

The potential heat values of energy sources used in the Pacific Northwest in 1951 was computed by Kolde(3) as follows:

Source	Trillions of Btu
Coal	86.9
Petroleum	514.2
Natural Gas	0
*Hydro Power	96.8

(*Note: Equivalent energy generated from mineral fuels would have required 446 trillion Btu.)

Kolde's(3) estimate of coal use distribution (Oregon, Washington, and Idaho) was as follows:

Use	Per cent of Total
Residential and Commercial Heating	25.1
Industrial Power or Heating (inc. Utilities)	30.2
Railroads and Vessels	10.9
Government Institutions and Projects	34.6

The 1951 coal use in Washington was 2,208,000 tons or 1.1 tons per capita. This compares to 0.73 for the three Pacific Northwest states and 3.10 average for the United States.

Coal production in Washington has declined almost continuously from four million tons in 1918 to 685,000 tons in 1953 due to the relatively higher production cost (40 per cent) over national average, competition from out of state coal sources, and petroleum, and dieselization of railroads and ships. Washington, the only coal producer for the three Pacific Northwest states, supplies only one-fourth of their coal demand. Some stimulus may come if the present planning for stand-by steam generating plants becomes a reality. Recoverable reserves are estimated at about 21 billion tons and are mostly sub-bituminous and bituminous.

Although coal is the only known mineral fuel found locally in commercial quantities the demand is low and is not likely to increase. Its use for stand-by steam generating plants, should it occur, would be under conditions conducive to maximum combustion efficiency and quite likely be at the coal source away from population centers. Unlike many eastern localities, the use of coal in Washington does not present a state-wide problem in terms of air pollution. There are localized problems within some communities as will be brought out later. Replacement of old equipment for utilization of oil or natural gas should gradually minimize these problems.

Petroleum is the major source of fuel in the Pacific Northwest, although there are no known local resources. Its use in Washington increased 152 per cent (compared to slightly under 100 per cent nationally) from 1940 to 1953 despite a population increase of only 45 per cent. In 1953, 47,731,000 barrels of petroleum fuels or 19.1 barrels per capita were used compared to 14.2 nationally.

The 1953 principal distribution of petroleum fuels in Washington was as follows(4):

Type	1000 Barrels	Per cent of Total
Fuel Oil	28,605	60.0
Diesel	3,507	7.4
Light	10,770	22.5
Heavy	14,264	30.0
Crude	64	0.1
Kerosene	183	0.4
Gasoline	18,943	39.6
TOTAL	47,731	100.0

The use distribution of petroleum fuel oil for 1953 was as follows(4):

Use	1000 Barrels	Per cent of Total
Heating	13,602	47.6
Manufacturing and Mining	6,821	23.9
Railroads	1,648	5.8
Gas and Electric Plants	1,389	4.8
Vessels	2,633	9.1
Miscellaneous	2,512	8.8
TOTAL	28,605	100.0

Motor fuel (gasoline) consumption has increased from 379,004,000 gallons in 1940 to an estimated 844,200,000 (2,310,000 average daily) in the 12 months period ending July 1956.

Present refining capacity in the State is about 80,000 barrels per day. Total capacity in the next four to five years may reach 250,000 barrels per day based on estimates of installations under consideration. Most or all of the refineries will be in the Puget Sound area close to water transportation. Present large refineries are located away from population centers and have installed modern recovery and control equipment. From the standpoint of air pollution control, this trend should be followed.

Petroleum fuels are destined to remain a major energy source for Washington. The combustion of petroleum fuels can be accomplished at high efficiency with proper controls for temperature and air. Poor combustion is a source of black smoke and sootfall and results in "general dirtiness", reduced visibility, soiling and nuisance. Black smoke from public and commercial buildings, apartment houses, and schools, and industrial plants is not an uncommon sight particularly during the fire-up periods.

Gas consumption in Washington has been confined to urban centers utilizing manufactured gas. Natural gas became available in Washington late in 1956 and is expected to replace all "local" gas and assume its share of the fuel market. Eighty-three per cent or better of the manufactured gas has been oil gas. No coal gas has been produced since 1947. The 1951 production and consumption of manufactured gas in Washington was 31.3 million therms (3.13 trillion Btu), with the following use distribution:

Type of User	Per cent
Residential	58.5
Commercial	35.8
Industrial	5.7

A typical estimate of total natural gas use in the fifth year of operation (1961) is shown below(5):

Location	Millions of Cubic Feet
Spokane	9,203
Wenatchee	758
Bellingham	2,841
Seattle	13,557
Everett	327
Tacoma	1,552
Olympia	211
Centralia-Chehalis	221
Kelso-Longview	379
Camas-Washougal	95
*Unallocated	1,877
Total through Utilities	31,021
*Direct to Industry	3,750
GRAND TOTAL	34,771

*Assumes one third of estimates for unallocated and direct-to-industry sales respectively for Pacific Northwest.

The approximate distribution by uses derived from this estimate would be:

Use Type	Per cent
Domestic	30 - 35
Commercial	10
Industrial	55 - 60

Thirty-five billion cubic feet of natural gas is approximately equivalent to 5,800,000 barrels of fuel oil. By 1959, a supply line with an annual capacity of 163 billion cubic feet will be available to the Pacific Northwest(6).

Major industries expected to be users of natural gas include: pulp and paper; food products; stone, clay and glass; cement and brick; and primary metals. Western Washington industry has contracted for 63.5 million cubic feet daily on an interruptible demand basis. One-third of this amount will be used by wood products industries (notably pulp and paper plants) in the Puget Sound area. Metal and food processors rank second and third respectively under present contracts(7).

The conversion to natural gas now underway in many cities can be expected to materially reduce emissions to the atmosphere of particulates, hydrocarbons, soot, and oxides of nitrogen and sulphur associated with the combustion of oil. This should be particularly evident where industry has used large amounts of heavy oil in their power plants. Where conversion is from coal to natural gas, emissions of sulphur, black smoke and fly ash should be materially reduced where good coal combustion controls have not been used.

Current information as to the use of wood and wood wastes is almost non-existent although, historically, the Pacific Northwest has relied to an unusual extent on wood as a source of both industrial and domestic fuel. The latest reliable estimates of the amount of wood consumed as fuel were made in 1944. It was then computed that about 760 million cubic feet of wood wastes (one quarter of the national total) were produced in the Pacific Northwest of which about 620 million cubic feet were used as fuel. Although the lack of reliable data makes estimates of current use quite hazardous, it has been stated that the use of wood as a fuel has declined since that time and that in 1951 only some 400 million cubic feet were utilized in this way(5). There has been a rapid increase in recent years in the use of wood wastes for pulp and for pressed wood products. There are still, however, a substantial number of wood products industries which are utilizing hogged fuel as a source of energy and disposing of sawdust and other wood wastes by burning. Modern power plants with proper feed and combustion control can burn hogged fuel efficiently without the emission of excessive smoke and cinders. Obsolete plants and the burning of sawdust as a means of waste disposal, however, still constitute a widespread problem, largely as a localized nuisance in the vicinity of the particular installation. The solution to this problem is expected to eventually come from the adoption of efficient burning methods and the by-products utilization of waste materials.

It may be concluded that, in contrast to Eastern cities, coal is not a very important source of air pollution in Washington communities since its use as a fuel is relatively limited. While the conversion to oil and natural gas will tend to reduce emissions of particulate pollution, the increasing use of these fuels, in addition to the others, will still result in substantial emissions of nitrogen oxides, sulfur oxides, aldehydes as well as organic acids, and other organic substances.

TRANSPORTATION

In evaluating the air pollution problem from transportation, consideration must be given to motor vehicles, railroads, and marine vessels.

Motor Vehicles - The role of automobile exhaust in air pollution is of increasing concern in large communities throughout the country. The pollutants discharged in auto exhaust include: substantial quantities of particulates, gases, and vapors(46).

In 1953 there was approximately one automobile for every 2.9 persons in Washington -- the average for the entire country was about one for every 3.4 persons. In that year there were approximately one million automobiles in Washington and they were driven approximately 11 billion miles (Figure 5).

Emissions from motor fuel consumption is considered to be one of the chief causes of smog in several West Coast cities. Statistics on motor fuel consumption for the State of Washington and King County, estimated for the 1955 - 1956 period, are:

	Washington	King County
Population	2,615,900 (a)	796,000
Automobiles	930,000 (b)	362,000
Persons Per Vehicle	2.81	2.2
Gasoline Consumption - daily	2,310,000 (c)	750,000

(a) Average of 1955 - 1956 estimates

(b) Allocation of Road and Street Costs - Highway Research Council

(c) Liquid Fuel Tax Division - Department of Licenses

The greatest motor fuel consumption takes place in July and August when motor vehicles consume an average of 2,700,000 gallons each day. Then consumption decreases rather uniformly to an average low in February of about 2,000,000 gallons per day. Vehicles do not burn all of this. Actually about 6000 gallons are lost each day in the form of vapors (hydrocarbons) due to evaporation and handling(4). The bulk of this comes from automobile exhausts but some escapes through the breathing of automobile tanks and carburetors. Motor vehicles emit significant quantities of hydrocarbons and nitrogen oxides, and relatively smaller amounts of aerosols, sulfur oxides, aldehydes, ammonia, organic acids, and other organic substances. Other pollutants result from the use of additives to gasoline such as

MOTOR VEHICLE TRANSPORTATION
STATE OF WASHINGTON: 1906 TO 1955

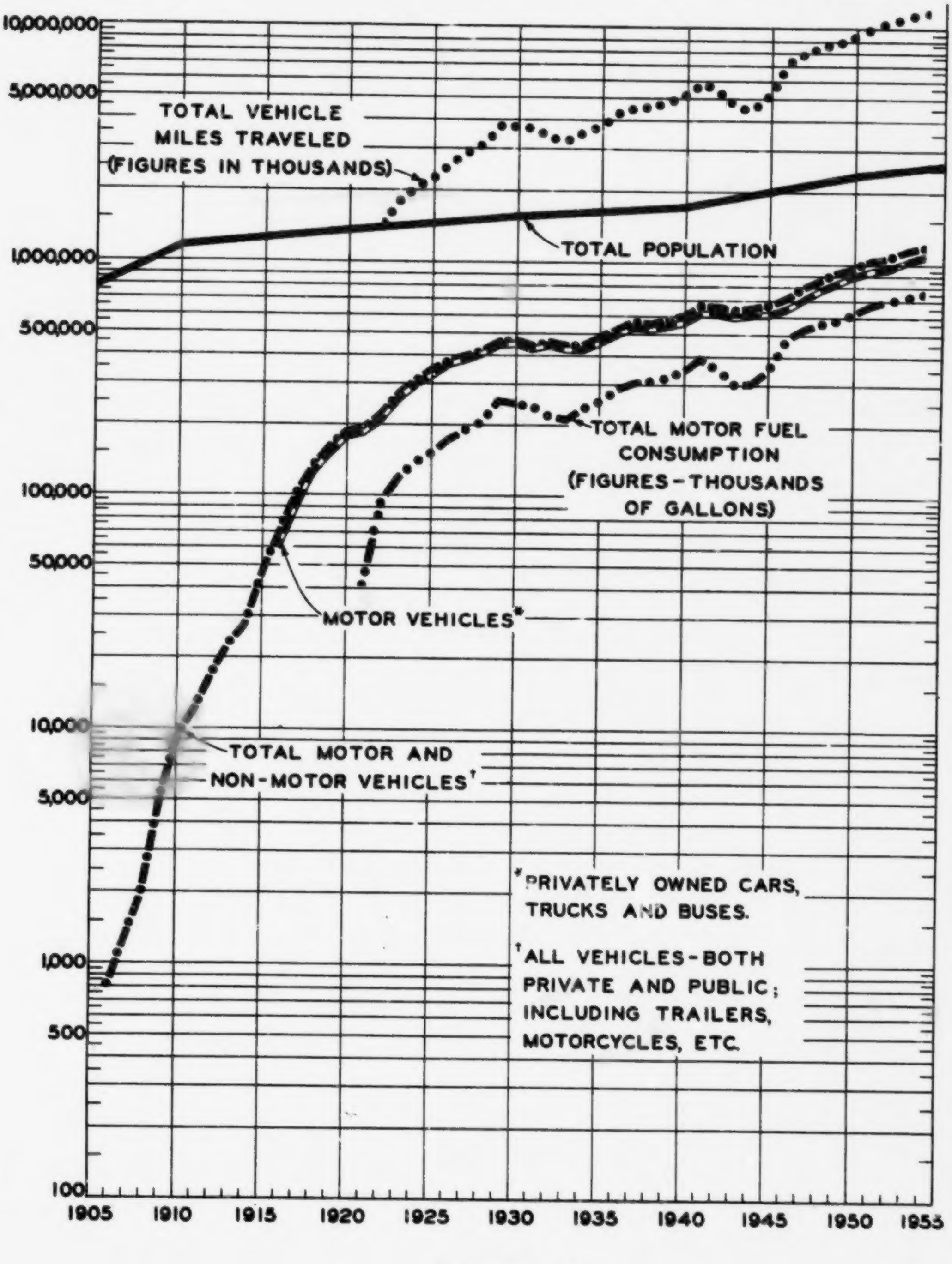


FIGURE 5

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MOTOR VEHICLE TRANSPORTATION STATE OF WASHINGTON: 1906 TO 1955

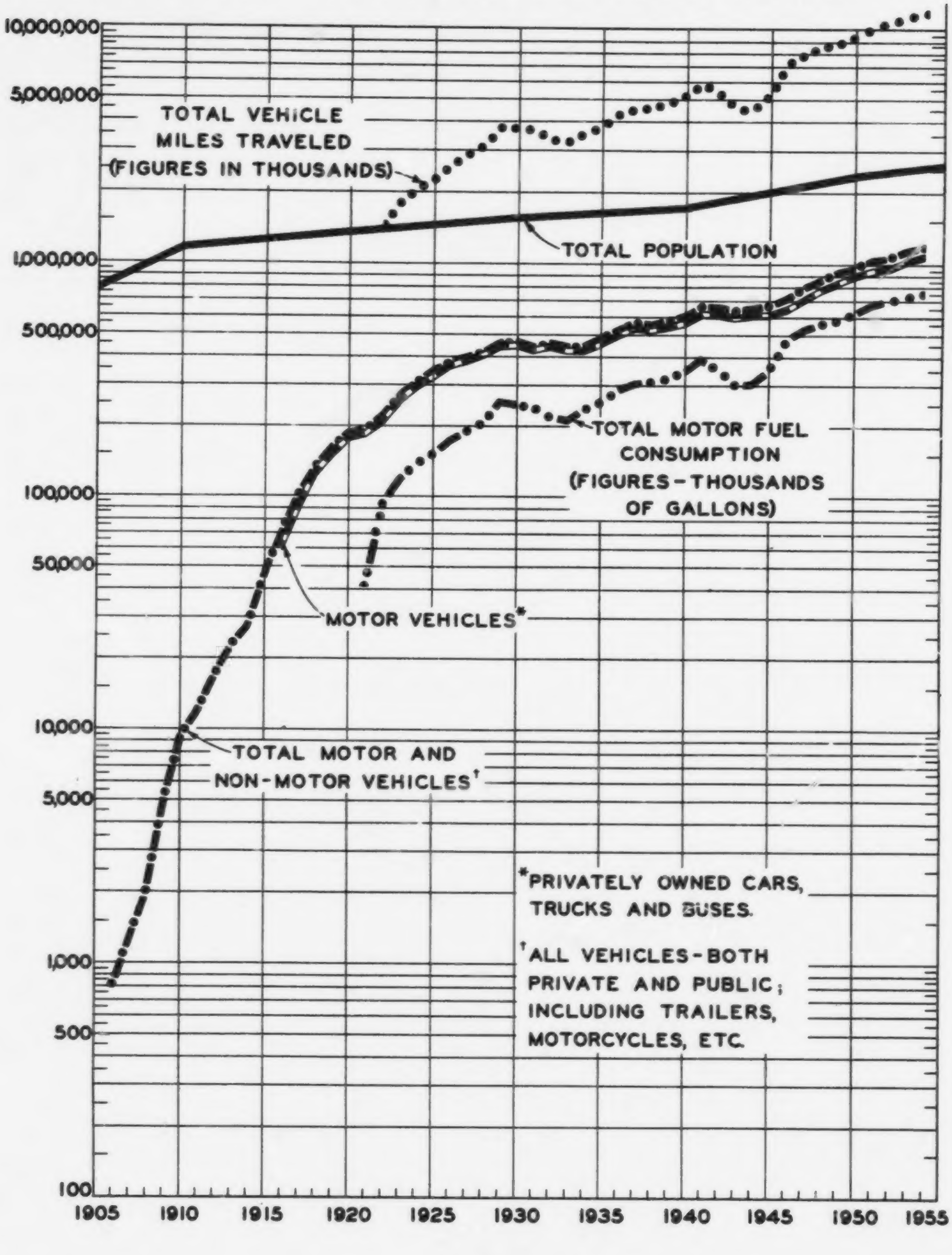

FIGURE 5

tetraethyllead and detergents. Motor oils and their additives are another source of pollution.

The following table is an estimate of the emissions from motor vehicles based on current knowledge and assuming an "average maximum" (defined below) daily fuel consumption of 3,500,000 gallons as a basis for Washington estimates:

Pollutant	Tons of Pollutants Per Million Gallons of Gasoline*	Tons Per Day		
		Washington		King County
		Avg.	Avg. Max.	Average
Hydrocarbons	200	462	700	150
Nitrogen Dioxide	40-160	92-370	140-560	30-120
Sulphur Dioxide	8	18	28	6
Other	Significant Quantities			
Aerosols				
Aldehydes				
Organic Acid				
Acetylene				

*Based on various published data

It is to be remembered that the local statistics given here are for large areas wherein there are many square miles of uninhabitated or sparsely settled land. This is particularly true in the mountainous areas and in the eastern part of the State, except for the several major cities. The concentration of population in the Puget Sound and Spokane areas, of course, is accompanied by a concentration of autos, buses, trucks, taxis, etc. While the overall effect of emissions from vehicle exhaust is impossible to estimate within the scope of the study, it is considered to be a problem of some significance at the present, and may become more serious as population and traffic increase. For this reason, an attempt has been made to estimate the gasoline consumption and emissions for certain cities. In doing this, the vehicle mileage estimates made by the Washington State Council for Highway Research have been used(8). These data were adjusted according to population increase. They were further adjusted on the basis that in the maximum month of consumption, 1.2 times as much gas is used as in the average month. By assigning the gasoline consumption to a 24 day period for the maximum month, the resultant is termed the "average maximum" daily consumption. These data are recorded in the individual city discussions.

Local traffic patterns may have quite a pronounced effect on the total exhaust emissions as well as the concentration occurring in a small area. Since most of the emissions are thought to occur during the acceleration and deceleration periods, smooth traffic flow becomes important in reducing emissions and heavy concentrations during local traffic congestions. Good traffic engineering, therefore, becomes an important element in air pollution control.

Our present state of knowledge of the formation of eye irritating smog is inadequate. We, therefore, cannot say how near the Puget Sound basin is to the Los Angeles type of smog. It is, however, reasonable to assume that continued increase in the rate of emission of automobile and other exhausts to the air in this region will increase the probability that on a number of days per year meteorological conditions will confine the emissions to the basin, and that the confined gaseous mixture will have eye irritating properties.

For purposes of comparison, the data on motor fuel consumption and automobile exhaust emissions for Los Angeles* are:

Population	5,000,000
Automobiles	2,500,000
Persons per Vehicle	2.0
Gasoline Consumption - daily	4,600,000
Emissions (Average - in tons per day)	
Hydrocarbons	1,090
Nitrogen Dioxide	770
Sulphur Dioxide	36
Aerosols	30
Aldehydes	113
Organic Acid	13
Acetylene	37

(The above data obtained from interview with Los Angeles County Air Pollution Control District).

Railroads - There are five major railroad companies operating in this State. They are:

GN	- Great Northern
NP	- Northern Pacific
CMSt.P & P	- Chicago, Milwaukee, St. Paul and Pacific
SP & S	- Spokane, Portland and Seattle
UP	- Union Pacific

The vast majority of the trains operated by these companies utilize diesel-electric locomotives as their prime movers. These range in size from a 380 horsepower switch engine to the 2000 HP giants of the road. However, most switch engines are 1000 - 1200 HP and most passenger and freight engines are 1500 - 1750 HP.

Only one company still operates oil- and coal- steam locomotives, but these are being replaced as rapidly as possible with diesel-electric engines.

This modernization is to be completed by the end of 1957. As of September 1956, there were about 14 oil-steam and 10 coal-steam switch engines with each working one 8-hour shift per day (all operating west of the Cascades). In addition, there are 15 coal-steam locomotives pulling freight trains between Seattle and Tacoma each day and 9 such engines working between Tacoma and Portland. The only other instance in the State is an oil-steam locomotive operating on a short branch line between Pacso and Richland.

Another company has electrified its main line eastward from Tacoma over the Cascades and into the Columbia Basin. Thus the pollution potential of the affected areas is lessened.

A main traffic artery extends from Portland, Oregon to Vancouver, British Columbia. A study and tabulation of the flow of locomotive units over this route shows that it increases as Tacoma is approached from the south; is heaviest between Seattle and Everett (over 90 units per day) and then thins out further north.

The east west routes of the GN, NP, and CMSt. P & P railroads cross the Cascades at three points in King County. The UP and SP & S trains follow the Columbia River through this barrier. The rail lines spread out extensively over the Columbia Basin with Spokane and Pasco serving as the major points of concentration. There are several branch lines running northward into the mountainous northeastern part of the State with a relatively small flow of traffic over these lines.

The extensive lumbering done in Washington results in many small, company-owned railroads which transport the logs from the mountains to the mills. It is understood that the locomotives used are all small diesel units. This fact plus consideration of their area of operation leads to the conclusion that their contribution to the air pollution problem is small.

There is no doubt that the contribution of dust fall and dirtiness by railroad locomotives is relatively insignificant. The few existing major offenders will soon be eliminated. However, it must also be remembered that the burning of diesel oil results in products of combustion including oxides of nitrogen and non ether-soluble aerosols(15). A diesel unit (there are usually 3 or 4 per freight train) burns about 2 gallons of diesel oil per mile while diesel switch engines burn 7-3/4 to 8 gallons per locomotive yard hour (9).

As would be expected, the heavier traffic of locomotives and switch engines is in the large centers of population. It follows then, that due consideration must be given to the diesel's contribution of oxides of nitrogen and minute particles to the caldron of pollution over the cities. The determination of the significance of this contribution in the major metropolitan areas is suggested as meriting future study.

Shipping - It does not appear that vessels are contributing much to air pollution in Washington.

During 1955, 1889 commercial vessels of over 1000 net registered tons sailed into Puget Sound through the Strait of Juan de Fuca. These vessels had a capacity of over 8½ million tons. The table below compares the activity on Puget Sound to other major ports(10):

Port (1954)	No. Vessels Over 1000 Net Registered Tons
New York	12,607
Philadelphia	9,124
Hampton Roads	5,548
Los Angeles	5,445
Baltimore	4,810
San Francisco	4,662
New Orleans	3,774
Houston	3,574
Boston	2,236
SEATTLE (Puget Sound)	2,106
Portland	1,437

Of the 1889 total number of vessels, three-fourths were oil-steam driven and the remainder were diesel driven. Coal-fired vessels are no longer seen in Puget Sound -- therefore, there is not a great deal of visible smoke from ships with the exception of the relatively infrequent occasions when a boiler is being fired up after a layover in port. During such periods of getting up steam (about a half hour) local nuisances may be created.

No tabulation is available concerning the ultimate destination of these nearly 2000 vessels. They call on various ports of Puget Sound and some of them, of course, call on more than one port. Following is the estimate from a member of the Puget Sound Pilots' Association:

Destination	Per cent of Those Entering Puget Sound
Seattle	At least 60
Tacoma	30-40
Olympia	30-40
Everett	30-40
Bellingham	30-40
Anacortes	10
Ferndale	10

In addition to the 1889 large commercial vessels, there were 200 MSTS (Military Sea Transportation Service) vessels of which about 50 participated in the DEW Line operation (depart in July - return in September). There is an occasional military cargo vessel and there are, of course, the ships of the Fleet which ply these waters.

Then too, there is a considerable number of smaller vessels on Puget Sound. There are many fishing boats, pleasure craft, ferry boats, tugs, and excursion boats burning petroleum fuels.

The Columbia River is also a major route to harbors of the Northwest. Approximately 1460 vessels of over 1000 net registered tons sailed into and out of the Columbia last year (1955) to call on the ports at Portland, Longview, and Vancouver.

There are two additional harbors on the Coast of Washington -- Grays Harbor and Willapa Harbor. The vessel activity at each of these approximates that at Olympia, or about 190 vessels last year.

The products of combustion resulting from the operation of these large and small vessels undoubtedly amounts to tons per day but they have not been considered principle sources of nuisance or damage. The determination of the type and amount of emissions contributed and their significance is suggested as more refined studies are conducted.

INDUSTRIAL ACTIVITY

The major producing industries in Washington are Metals and Chemicals, Forest Products and Agriculture. The annual farm output has a value of about $600 million which is roughly equivalent to the value added by each of the other two major producers.

Employment figures are not accurately available for Agriculture. The manufacturing payrolls distribution for all classifications are shown on the next page(11).

The dominant position of Metals and Chemicals is due mainly to the extensive Boeing Airplane Company operations in Seattle which has some 40,000 employees. This represents about 47 per cent of the manufacturing payroll in the Seattle area. The number of local sub-contractors, however, is quite limited for the size of the industry -- a large share of the work being done out of State.

Washington Manufacturing Payrolls

(12 Months Ending September 30, 1955)

Total Payroll - $947 Million

	Per cent Total Payroll Dollar		Per cent Total Payroll Dollar
Forest Products	**36.3**	**Metals and Chemicals**	**45.1**
Logging and lumber	18.2	Aircraft	20.0
Pulp and paper	8.6	Chemicals (Including Hanford)	7.0
Plywood, millwork, etc.	7.7	Basic nonferrous	5.5
Furniture	1.4	Machinery	3.4
Other	.4	Fabricated products	3.2
		Shipbuilding	2.5
		Basic ferrous	1.7
		Other	1.8
Food Products	**10.3**	**Other**	**8.3**
Canning and preserving	3.3	Printing and Publishing	3.9
Bakery goods	1.6	Stone, clay, glass products	1.7
Meat products	1.6	Textiles and apparel	1.4
Beverages	1.6	Miscellaneous	1.3
Flour, grain mill products	1.0		
Dairy products	.6		
Other	.8		

The aluminum industry has continued to expand since 1940 being attracted by low-cost electric power. Major installations are at Spokane, Wenatchee, Vancouver, Longview, and Tacoma. One is just across the southern border at Troutdale. A new reduction plant is under construction just across the southern border at The Dalles, Oregon.

While the steel industry does not occupy a large share of the State manufacturing economy, there is one large open-hearth furnace plant in Seattle. Plans for conversion to electric furnaces will increase its capacity from 246 to 420 thousand net tons annually in about three years.

Historically, the Forest Products group has been a major support of the State economy and can be expected to so continue in supplying the lumber demand and in expanding the wood utilization specialities such as pulp and paper, hardboard, and plywood. The State Division of Forestry estimates that there are 19,874,000 acres of commercial forest containing 289 billion board feet of saw-timber. Of this, there are over 11 million acres west of the Cascades in the fir region and nearly 9 million acres east of the Cascades in the pine region. The annual dollar value of forest products is nearly $900 million. Sustained yield practices are in effect.

Major forest products and the 10-year production growth are as follows:

	1955 Production	Per cent Growth since 1945
Lumber	3,666 million board feet	12.5
Pulp	2,579 thousand tons	104.0
*Plywood	4,911 million square feet	326.0

*Washington, Oregon, and Northern California

Chemical pulp plants are located at:

Anacortes	1	Port Townsend	1	Shelton	1	Camas	1
Bellingham	1	Everett	4	Hoquiam	1	Millwood	1
Port Angeles	2	Tacoma	1	Longview	2	Vancouver	1

One plant is just across the eastern border at Lewiston, Idaho. A new 400 ton plant is under construction at Cosmopolis.

It is estimated that there are about 40 plywood plants and over 500 sawmills.

There are two major petroleum refineries now in operation at Ferndale and Anacortes with a total capacity of some 80,000 barrels daily. Additional refineries to a total of some 250,000 barrels daily capacity are expected in the next four to five years.

The Columbia Basin has undergone a phenomenal growth as the 600,000 acre irrigation program gets underway. The most important industry based on Basin products is the large sugar beet plant at Moses Lake. Industries developing to serve the Basin include the ammonia storage plant at Pasco, the ammonia converting and distribution center at Walla Walla, and the ammonia fertilizer plant near Kennewick. The Seattle - First National Bank estimates that by 1965 the Columbia Basin wholesale and retail trade will increase to $316 million dollars and $30 million dollars will be added to manufacturers economy.

Mining is undergoing stimulation in the northeastern part of the State with the filing of many uranium mining claims and the possibility of an ore processing plant. Production of lead, zinc, and copper has been encouraged in this area by rising prices.

The manufacturing employment of 202,300 represents only about 36 per cent of total employment excluding agriculture and government. Government employment is about 147,000. Accurate agricultural employment information data are not available but is estimated to be about 85,000 annual average.

The distribution of employment by area and major classification for 1955 is shown on the following table(12).

1955 EMPLOYMENT IN WASHINGTON - DISTRIBUTION BY AREA AND MAJOR TYPE

(Exclusive of Agricultural Labor, Domestic Service,
Government, Railroads and Miscellaneous Minor Service)

Industry Division	Average Monthly Employment As Per cent of State Total (1) Metropolitan	(2) Northwest	(3) Southwest	(4) Eastern	*Total State Employment (Thousands)	Total State Payrolls (Millions of Dollars)
Mining and Quarrying	16.7	4.2	4.2	70.8	2.4	11.7
Contract Construction	39.6	13.8	15.9	29.1	46.5	234.8
Total Manufacturing	48.8	12.4	19.5	19.3	202.3	964.5
Logging, lbr., wood prod., furn.	(24.7)	(20.9)	(40.6)	(12.5)	55.9	260.8
Other durable goods mfg.	(77.6)	(3.5)	(4.4)	(14.3)	79.6	397.6
Food & Kindred Products	(42.1)	(13.8)	(13.4)	(30.8)	24.7	99.4
Other nondurable goods mfg.	(29.8)	(17.3)	(23.7)	(29.1)	42.2	206.7
Transp., comm., & utilities	55.9	11.4	10.8	21.0	47.2	218.1
Trade (Wholesale & Retail)	51.6	10.4	8.4	26.9	170.8	629.9
Finance, insurance, real estate	63.0	7.2	6.0	21.7	33.2	131.6
Services	52.7	10.1	9.3	26.4	64.3	187.9
Not elsewhere classified	41.7	20.8	8.3	8.3	2.4	10.9
Total					569.2	2389.3
Per cent State Total	50.6	11.3	13.1	23.6		

*Includes Multi-County (i.e. employers operating in several counties but with less than 50 total employees accounting for about 1.4 per cent of total State employment.)

(1) Metropolitan - King and Pierce Counties
(2) Northwest - 8 Counties - Clallam, Jefferson, Snohomish, Kitsap, Skagit, Whatcom, Island, San Juan
(3) Southwest - 10 Counties - Grays Harbor, Mason, Thurston, Pacific, Lewis, Wahkiakum, Cowlitz, Clark Skamania, Klickitat
(4) Eastern - 19 Counties

AGRICULTURE

The 1955 annual value of farm products is shown below(11):

Value of Farm Products - 1955

	Millions of Dollars	Per cent Total
Field Crops	$218.3	37.3
Livestock and Dairy	194.3	33.2
Fruits and Berries	121.5	20.7
Specialty	31.8	5.4
Vegetables	19.7	3.4
Total	$585.6	100.0

In general, timber predominates west of the Sound and along the Coast; dairying and specialty crops are east of the Sound and south to the Columbia River; timber is again the main crop in the Cascades. Fruit of various kinds is the principal crop in the valleys of the Okanogan, Columbia, and Yakima River valleys. An extensive livestock area centers around Ellensburg. Cash crops such as sugar beets, vegetables, and hay are grown extensively in the irrigated Columbia Basin. Timber again predominates in the northeast, and the entire eastern dry land area from Spokane south is devoted to wheat and peas. Total cropland exceeds 17 million acres exclusive of the Columbia Basin.

The Columbia Basin will add immensely to Washington crop production. Population is estimated to rise from 32,000 in 1950 to over 127,000 in 1965. Upon completion of the 600,000 acre program in 1965, crop values for the basin are expected to rise to some $81 million and livestock and dairy products to $46 million.

Damage to agriculture by industrial air pollution was reported in the following areas(13):

Everett - SO_2 damage to ornamentals attributed to pulp mill.

Spokane - fluoride damage to pine trees, ornamentals and hay attributed to aluminum smelter.

Spokane - particulate damage attributed to ferro-alloys plant.

Camas - fluoride damage to dairy cattle and garden crops attributed to aluminum smelter in Oregon.

Longview - fluoride damage to dairy cattle and hay attributed to aluminum smelter.

Wenatchee - fluoride damage to peaches attributed to aluminum smelter (this is just now coming under investigation).

Vancouver - fluoride damage to dairy cattle and hay attributed to aluminum smelter.

Tacoma - fluoride and SO_2 damage to ornamentals attributed to smelter.

Improvements at most of these plants have since been made to reduce pollution.

The State College of Washington, Western Washington Experiment Station at Puyallup, has conducted a series of investigations into vegetation damage from atmospheric fluorine(42) (43). Marginal scorch on Italian prune foliage was investigated in 1944 through 1946. It was found to occur in the areas of Washougal, Vancouver, Longview and Tacoma in 1944 and 1945. In 1946 leaf scorch was found in the areas of Vancouver and Longview but not in Washougal and Tacoma following closure of the aluminum plants in the latter places. In 1947 and 1948 leaf scorch of gladiolus was investigated and found to occur at Troutdale, Oregon; Tacoma, and Spokane. In the Tacoma area there was no injury to the plants when the aluminum plant was closed during the growing season of 1947. At Mount Vernon, in an area free from atmospheric fluoride pollution, gladiolus remained free of scorch during the same period of study. By further studies a method was developed for detecting atmospheric fluorides by the use of lime papers and indicator plants(44). At the present time the Western Washington Experiment Station maintains a series of sampling stations at which atmospheric fluorides are routinely determined. There are 5 stations in Tacoma, 9 stations in Clark County, 8 in Cowlitz County, and 5 in Pierce County. A station is maintained at Mount Vernon as a reference station for fluoride free atmosphere.

Damage ~~from~~ to agriculture was reported in several instances(13). Spraying of wheat and other crops with 2,4-D from airplanes has caused damage to shrubs, grapes, and food crops in several areas. The State Department of Agriculture now has regulations pertaining to spraying practices.

Fruit orchard spraying was not considered to be a cause of damage to other crops nor to humans except those involved in the spraying operations.

Cultivation practices resulting in bare, plowed fields and newly prepared lands coupled with high wind velocities frequently create dust storms, some of which are quite severe.

REFUSE DISPOSAL

The vast majority of the communities in this State dispose of their refuse by dumping it at a designated location and burning it -- the common "open dump". Many of these dumps are located as much as 10 miles away from town and some of these have presented no serious air pollution nuisance, but others have been cited as the "worst problem in town".

Of the 41 cities of over 4000 population, 34 practice burning of rubbish or garbage or both. Two of them utilize incinerators and there are several "sanitary landfills". The Wenatchee and Walla Walla sanitary landfills have received much deserved praise. Action is currently being taken in Seattle toward halting of all burning at the refuse disposal sites. Twelve of the cities do not have compulsory collection requirements and five of these are in the over 10,000 population category(14). The majority of cities under 4000 population burn garbage and/or rubbish.

A wide variety of substances including both gaseous and particulate matter arises from incineration of refuse. They include aerosols, oxides of nitrogen and sulfur, aldehydes, and organic acids. Local situations will be discussed in more detail for several of the cities later in this report.

OUT OF STATE SOURCES

Air pollution recognizes no state or other artificial boundaries. Although this investigation was concerned with the State of Washington, there are several sources of pollution outside the State which at times affect Washington citizens.

The extensive activities at Trail, British Columbia have in the past caused considerable damage in the State of Washington. At the present time, there is some concern that damage is still resulting. Emissions from the 1000 ton smelter operation at Trail are well controlled, and monitoring stations for specific polluting materials are maintained along the border. "Meteorological control" of the processes is practiced. Of concern to the State of Washington is the possible damage to agricultural activities in the river valleys leading into the State from that point in Canada. The operating regime was established by an international tribunal after the award of $428,000 damages through 1938(15).

A sulfate pulp mill at Lewiston, Idaho seriously pollutes the canyon leading into the State of Washington near Clarkston. The air-borne effluents from the pulp mill cause severe odor problems and significant reduction of local visibility. Temperature inversions are usually present in the canyon and result in the accumulation of the emissions. It is reported that visibility at the level of the Clarkston airport and below is sometimes considerably reduced as a result of this emission. There is no air pollution control program in Idaho.

At Troutdale, Oregon an aluminum reduction plant is located directly across the river from Camas. The winds, affected by the unusual local topography, occasionally carry emissions from this plant into Washington.

Portland, Oregon lies just across the river from Vancouver. Under certain meteorological conditions, the pollution of this metropolis is carried into Washington.

In the two latter cases, pollution from Washington sources may be carried into Oregon under proper wind conditions. Oregon has a State Air Pollution Authority whose staff is under the direction of the State Sanitary Engineer. Part of the staff is employed jointly by the State Board of Health, Sanitary Authority and Air Pollution Authority.

NATURAL SOURCES

There are two natural sources of air pollution in the State which are of considerable magnitude. Forest fires and dust storms both represent a loss of natural resources which every attempt is made to control. Forest fires may be present in many parts of the State, while dust storms from plowed fields are confined principally to the dry portion east of the Cascade Mountains. Both of these are of considerable, although temporary, consequence.

RESOURCES AVAILABLE FOR FUTURE RESEARCH OR INVESTIGATION

The University of Washington and the State College of Washington have been active in air pollution for approximately six years. Each has staff members who are particularly competent in various aspects of the problem due to their participation in field and/or research studies. The laboratory facilities and field equipment available compare favorably with nearly any other institution in the country.

Meteorological and climatological data are available from a number of stations throughout the State (Figure 4). The U. S. Weather Bureau currently maintains first order weather stations of which three send radiosondes aloft on a routine schedule. The Bureau maintains an office in Seattle where the State Climatologist, his assistant, and the Regional Coordinator are located. The experience of this personnel enables them to interpret data which would be meaningless to the layman.

There are in Washington industrial, commercial, and institutional analytical laboratories which possess a wide selection of equipment, facilities, and trained personnel. Although these laboratories may have quite limited experience in this activity, they nevertheless can make valuable contributions.

Tacoma is the only city in the State with a full-time air pollution control engineer.

SECTION TWO

PART III

SELECTED COMMUNITIES OVER 10,000 POPULATION

The following communities having a significant degree or potential of air pollution are discussed in detail:

Seattle
Tacoma
Everett
Spokane
Bellingham
Port Angeles
Olympia
Longview - Kelso
Vancouver
Aberdeen - Hoquiam - Cosmopolis

The following communities, having a lesser degree of air pollution, but which have a significant potential because of location, size or particular local circumstances are also discussed in summary form:

Yakima
Wenatchee
Richland - Pasco - Kennewick
Walla Walla
Bremerton
Renton
Puyallup

SEATTLE

GENERAL DESCRIPTION

Seattle, Washington's largest city, located on the easterly shores of Puget Sound, is the most westerly major United States port. It is served extensively by air, rail and highway transportation. Seattle and surrounding areas of King County is the largest and most important industrial, commercial and maritime complex in the region. It is a major center of trade, transportation business and services for the Pacific Northwest and Alaska.

Pertinent statistics concerning Seattle include:

Population 1940 - 368,302
1950 - 467,591
1956 - 562,500* (July Estimate)

Area - 90 Square Miles
Population Density - 6250 persons per square mile

* Includes annexation of over 15 square miles since 1950. Residential growth is to the north, east and south.

The Seattle metropolitan area, including King County's second largest city, Renton, (16,000) and numerous other incorporated cities and towns, has a population of some 700,000. The King County population is 616,700 (1956 estimate).

Comparing King County with the national averages, it has a much higher proportion of its total industry in transportation equipment (especially aircraft), lumber and wood products, foods, printing and publishing, and fabricated metal products. It is, however, far behind the national averages

Seattle (Cont'd.)

in tobacco products, textiles, apparel, furniture, paper and paper products, chemicals, petroleum and coal, rubber, leather, stone-clay-and glass, primary metals, machinery, and instruments(16).

Seattle's major industrial area is in the Duwamish Valley (southern end), and future expansion will be in this area and further south into the lower Green River Valley. The Port of Seattle is planning a major industrial site development program in this area.

TOPOGRAPHY AND CLIMATOLOGY

Seattle is situated on a rather narrow land strip bounded on the west by Puget Sound and on the east by Lake Washington. The east-west width is 6 to 7 miles except where Elliott Bay pierces into the heart of the city from the west near its north-south mid-point leaving a narrow strip to the east, less than three miles wide. North and south the corporate limits cover about 15 miles. Seattle is quite hilly and generally divided by valleys.

The southern third is divided by the Duwamish River Valley about 2 miles in width, lying on a generally northwest-southeast axis. This valley is the major industrial area usually referred to as the south industrial section. Hills rise from the valley to over 500 feet on the west and over 350 feet on the east. The central portion of the city rises from Elliott Bay tidewater through the business district to over 400 feet in the apartment district and down again to Lake Washington level. North of the central district the land body is cut by the Lake Washington Ship Canal trough, lying on an east-west axis, connecting the Puget Sound and Lake Washington. Lake Union, centrally located on the waterway, and Salmon Bay and the Government Locks area on the west contain the north industrial area.

Seattle (Cont'd.)

North of the waterway the land rises to a general level of 300 - 400 feet, reaching over 500 feet at the northern limits.

Lake Washington is about 17 miles long and generally 2 to 3 miles wide. The land to the east rises to 500 - 1000 feet and falls off again to Lake Sammamish and contiguous valleys.

To the south a high ridge, approximately 400 feet high and 2 to 4 miles wide, extends along the Sound on a north-south axis. The Green River Valley, two to three miles wide, lies east of this ridge. Its trough elevations range from 30 feet up to 90 feet at Auburn. Its northerly drainage is the Duwamish River, however, it is part of the trough extending north to include Lake Washington. The valley is largely utilized in truck farming and contains the cities of Renton, Kent and Auburn. The valley trough extends further south to Sumner and joins the Puyallup River which drains its southern portion through Tacoma's industrial area. The valley contains the best sites for expansion of Seattle industry. As such it presents a potential problem in air pollution.

The climate is mild and moderately moist due to the prevailing westerly air currents advancing inland from the Pacific Ocean, and to the shielding effects of the Cascade Mountains which serve to exclude the cold continental air and deflect it toward the east. Despite its northerly latitude mid-winter temperatures are mild (40 to 50°). In the mid-summer heat season July temperatures average 64°. The warmest summer and the coldest winter days come with north to east winds traveling under land influences from British Columbia or eastern Washington. When this wind occurs in winter, nighttime inversions and prolonged periods of stable air can be expected.

Seattle (Cont'd.)

A review was made of the wind records from the U. S. Weather Bureau at the Federal Office Building (at First and Marion, downtown Seattle, close to Elliot Bay), Boeing Field (in the south industrial Duwamish Valley area), and Seattle-Tacoma International Airport (11 miles south of the Federal Office Building and on the high ridge at elevation 380 between Puget Sound and the Green River Valley). At Sea-Tac the prevailing wind is southwest 10.1 mph. At Boeing Field the local topography channels the air movement to give a prevailing wind of south-southeast 7.7 mph in alignment with the axis of the Duwamish Valley. At the downtown station the prevailing wind is southeast 9 mph. The pronounced effect of the topography is apparent in that the wind velocity at Boeing Field is consistently lower by about one third and the per cent of calm higher than at Sea-Tac throughout the year. This difference may be partially or wholly ascribed to differences in instrumentation, exposure and calibration. The higher percentage of calm winds at Boeing Field is particularly noticeable in August or September when northerly winds prevail.

According to published Weather Bureau records (64 years) light northerly winds prevail over the downtown area in July, August and September and frequently from May through October. This is significant in that emissions from this area can be carried into the south industrial area and add to the already present concentration of pollutants. Diurnal effects on the stability and wind flow in this area produce considerable variance in local pollution levels. Seven years of records from the Sea-Tac airport show that northerly winds usually occur only in September, and are southwest in July and August. The net result may be a concentration of the polluted air in the Duwamish Valley during the other two months.

On a larger scale the winds during the summer months are north at Everett, north at Tacoma and south-southwest at Olympia as a result of the topographical deflection of off-shore westerly winds entering through the Strait of Juan de Fuca and the Willapa Valley.

At Boeing Field the higher frequency of light notherly winds in the summer and the greater percentage of calm winds usually lead to the concentation of pollutants in the Duwamish Valley.

In the winter, southerly winds prevail over the Seattle area. On occasion cold stable air moves into the area from the north or east and may persist for extended periods. While there is generally a break-up of the atmospheric stability during the day in the lower levels, stable conditions may persist above 1000 feet for many days.

The characteristics of the lower 150 feet of air have been studied in detail at the University of Washington(2). The study covered the 10 month period, September 21, 1949 through July, 1950 and included about 7000 observations. Stable air was present over 50 per cent of the time from October through April, exceeding 75 per cent in February. Stable air was present about 30 per cent in May through July. Inversions were present 48 per cent of the time with maximum winter inversions of +6 F° and a maximum summer inversion of +13 F°.

POLLUTION SOURCES

Transportation - Seattle, as a major port and the western terminus for three major cross-country railroads, is an active transportation center.

Railroad movements are estimated to be as follows:

Seattle (Cont'd.)

1262 diesel-electric unit miles/day on passenger and freight trains

596 diesel-electric switch engine yard hours per day

98 coal-steam unit miles/day on freight trains

40 coal-steam switch engine locomotive yard hours per day

32 oil-steam switch engine locomotive yard hours per day

It is estimated that diesel-electric units burn 14,000 gallons of fuel oil daily within the City limits, about one-third of which is used by diesel-electric switch engines. One major rail line is electrified.

Because of the small amount of fuel used by diesel-electric units and their relatively efficient operation, their contribution is minor. The oil and coal-steam switch engines, however, produce considerable smoke which is a local nuisance and contributes to the general pollution. The company operating these units advises that they will be replaced by diesel-electric in 1957.

Shipping activity in Seattle is estimated to range from 1100 to 1200 ships annually of 1000 net registered tons and over. In addition are MSTS vessels (200 in Puget Sound in 1955), Navy craft, smaller commercial boats, tugs and pleasure boats. Ships are not considered a major problem except as a local smoke nuisance during fire-up after a lay-over period. Almost daily one can see at least one or two ships in dock emitting dense smoke for periods up to about 30 minutes.

Vehicle traffic in Seattle has been difficult to estimate. Data from various official sources has produced estimates ranging from 5 to 7.5 million miles daily. Gasoline consumption has been taken as 500,000 gallons daily for Seattle and 750,000 gallons daily for King County. On this basis the

Seattle (Cont'd.)

major emissions in Seattle proper would then be:

Pollutant	Tons Per Day
Hydrocarbons	100
Nitrogen Dioxide	20 - 60
Sulphur Dioxide	4

In addition emissions of aerosols, aldehydes, organic acids and acetylene are significant.

Domestic, Commercial and Municipal - Residential heating units by types are estimated to be as follows(17):

Type of Fuel	1956		1950	
	Dwelling Units	Percent	Dwelling Units	Percent
Oil	162,736	86.7	131,225	74.6
Coal or Wood	14,453	7.7	35,856	20.4
Gas	7,696	4.1	5,923	3.4
Electricity	4,317	2.3	2,785	1.6

These data show the marked decline of caol and wood both in total and per cent of use.

Residential oil use based on an average of 1000 gallons per central furnace and 650 gallons for space heaters, assuming two-thirds of the units are furnaces would be approximately 145,000,000 gallons for an 8 month heating season or 605,000 gallons per day. Cold days of peak demand would increase the rate substantially. Industrial demand is not known but was estimated at 110 per cent of domestic in 1950(23).

The bulk of the downtown area is served by a central steam plant. The approximate area of service is from the waterfront to King Street and Third Avenue, thence northerly to Virginia and 8th Avenue and back to the waterfront.

Seattle (Cont'd.)

Within this area are 635 services in 140 buildings representative of about 85 per cent of the area. Annually 240,000 barrels of Bunker "C" oil are burned of which 200,000 are burned in the 8 months heating season. This represents approximately 35,000 gallons per day. Natural gas has been contracted for in the amount of 104,000 barrel oil equivalent. Natural gas only will be used during the summer. Oil consumption during the heating season will then be reduced to about 24,000 gallons daily(18).

The use of coal in 1950 was estimated to be 140,000 tons for residential use and 160,000 tons for industrial use(23). The marked decline in residential coal units has probably reduced this use to 60 to 80,000 tons. Industrial, commercial and institutional use has also declined by an unknown amount.

Smoke from poor combustion at commercial and public buildings is not uncommon. An example is the City of Seattle Public Safety Building.

Seattle operates 6 garbage and refuse disposal sites as follows:

Location	Material	Method of Disposal
120th and Aurora	Refuse	Open Burning
2nd Ave. S. and Kenyon	Refuse	Open Burning
Interbay	Garbage	Fill and Cover
Union Bay	Garbage and Refuse	Fill and Cover
West Seattle	Garbage	Fill and Cover
42nd and Genesee	Garbage	Fill and Cover

Refuse burning at Interbay was stopped in the fall of 1956 and was stopped at Union Bay in 1955. Burning at both of these sites was a local nuisance as well as contributing to the overall atmospheric load. Problems still to be solved include elimination of all open burning and overcoming odors at sanitary fills, particularly the Union Bay site.

The city of Seattle operates an asphalt mixing plant on Lake Union. It has been the source of complaints about smoke, dust and odor.

Industrial Activity - The major industrial activity in Seattle includes:

Aircraft Manufacture. (Largest single payroll)
Steel Manufacture. (1 large plant)
Iron Foundry
Steel Rolling
Heavy and Light Steel Fabrication
Ship Building and Repair
Lumber, Plywood and Wood Fabrication
Cement Manufacture
Gypsum Products
Concrete and Clay Products
Asphalt Products
Flour Milling
Fish and Food Processing
Brewing

The following information is not intended to be a complete inventory of industrial sources but rather to demonstrate the types of problems encountered.

Industrial emissions include:

South Industrial Area

Steel Manufacturing Plant: Uncontrolled emission of ferrous oxide dusts. This plant has been a large user of oil. Conversion to natural gas is now underway. Ultimate use will be over 1 billion cubic feet per year. Planned conversion from open-

Seattle (Cont'd.)

	hearth to electric furnaces will increase capacity from 246 to 420 thousand net tons annually.
Iron Foundry:	Excessive smoke and dust. Company is trying to find solution.
Iron Works:	Heavy volumes of reddish dust. Controls not reported.
Lumber Mills:	Moderate to heavy smoke. Occasional cinders from burning of wood waste as fuel. Pulp chipping reduces amount of waste. Several plants operate waste wood burners with emission of smoke and cinders.
Plywood Mill:	Moderate to heavy smoke for short intervals from combustion of hogged fuel.
Cement Plant:	Dust emission. Controls not reported.
Gypsum Plant:	Dust emission.
Auto and Scrap Salvage:	Tremendous volumes of heavy black smoke and odor intermittently from uncontrolled burning of old car bodies and tires and other scrap. There are about six such operations and they are considered major offenders. This type of operation permits no control of combustion. (One state has required firing chambers with which control is possible.)
Burning Dumps:	One large municipal refuse burning dump in the south industrial area is a major smoke producer. A similar, but smaller, source is the City rehabilitation center salvage burning operation. The burning dump (garbage and refuse) operated by Seattle-King County Health Department to the south of the City in the Green River Valley is a major smoke contributor. It is particularly severe with nighttime drainage of cool air into the valley. During stable periods, the smoke is carried south toward Kent or into the Seattle industrial area depending on the wind direction.

North Industrial Area

Cedar Lumber Mill:	Excessive smoke and cinders over general area from burning of wood waste for fuel and disposal. Excessive sawdust in immediate

Seattle (Cont'd.)

	vicinity. Source of numerous complaints. Little control except screen on waste burner. Combustion and feed control devices for all boilers are to be installed.
Shingle and Plywood Mills:	Smoke and cinders reported in earlier studies.
Paving Asphalt Plants:	1 municipal, 1 City. Excessive smoke, dust and odor.
Tar Products Plant:	Very heavy smoke. Odor. Change to natural gas planned.
Manufactured Gas:	Heavy yellow-white and yellow-brown smoke plumes. Odor. Plant to be on stand-by status after natural gas conversion.
Steel Rolling Mill:	Occasional heavy smoke. Some dust. Mostly electric power.
Auto and Scrap Salvage:	Smoke and odor from burning old car bodies and tires.
Foundry:	Cupola blast. Reported as intermittent up to 2 hours daily.

There are a limited number of industries with severe emissions of process wastes. The primary problem results from combustion of fuels with efficiencies varying from good to poor as evidenced by stack emissions.

PREVIOUS STUDIES

Local interest in air pollution has been sufficient to stimulate a number of studies in Seattle.

One of the earliest studies was conducted in the summer of 1950(24). The study was limited to the Lake Washington Ship Canal trough, an area topographically confined and containing substantial industry, commercial operations, marine, rail and vehicular transportation and a variety of domestic activities.

In the North industrial area there were 129 industrial and heavy

Seattle (Cont'd.)

commercial sources. Of these:

33% were wood industries
15% were food industries
13% were chemical oil and paint
13% were metal industries
13% were concrete, sand and gravel

Total 87%

the remaining 13% were primarily boiler or heating plant smoke emitters. Ringelmann smoke comparisons, although limited in number, indicated a number of heavy "smokers".

Settled dust studies were made in the Lake Union area in July, August, and September -- a period when few space heating plants would be in operation. The average determination for 8 stations was 38.7 tons per square mile per month with a maximum of 55.6. Total water insolubles and total water solubles were quite consistently in the order of 70 and 30 per cent respectively. Although meteorological conditions were not reported in this study, one would expect little "outside effect" in this season. The study was short but the results were consistent. The results are high compared to what might be expected for the City average but not surprising in view of the area of study. Continuous air filter sampling, sulphuric acid determinations, and radiometric determinations were not conclusive.

A 1951 - 1952 study by the Environmental Research Laboratory of the University of Washington involved the determination of damage area and proportion of contribution by several industries concentrated along the Lake Washington Ship Canal(25). Freshly painted cardboards (120 square inches in area) located in a circle about each source were used. Correlation of

Seattle (Cont'd.)

visual contamination with wind direction was made. Two shingle mills, a lumber mill and a plywood mill were found to be offenders and their proportional contribution of damage to three used car lots was established. By means of dust fall jars, dust concentrations were determined on each of the complainant's properties. Individual averages ran as high as 264 and 189 tons per square mile per month respectively for total water insoluble dust and combustible material. This complainant received 10 times as much insoluble dust and 20 times as much combustible material as the average for the city.

This study emphasizes the effect of a poorly controlled source of pollution on the immediate vicinity.

The major study in Seattle was conducted by the Environmental Research Laboratory, University of Washington during the period from September 1950 to February 1952(23). Dust fall studies over a 12 month period at 27 sample stations were interpreted to indicate 27.5 and 53.1 tons per square mile per month for overall city average and industrial area, respectively. There was very little variation in the overall average from season to season. Significantly, however, zones of high concentrations were to the south during the summer and spring with northerly winds, and shifted northward during the winter with southerly winds. This would indicate that settleable particles were mainly from sources operating the year around and points out the significance of wind characteristics. On the other hand, filter samples collecting small, light particles, showed a significant increase in winter.

Air sampling studies in Seattle(36)(38), based on reflectance measurements and electron microscope observations of Seitz air filter discs showed

Seattle (Cont'd.)

that carbon, attributed to smoke, was a major air pollutant. The higher concentrations were observed during the winter months, as would be expected.

Spot sampling was done at 14 stations for several weeks in August and September, 1951. The results are summarized as follows:

Electrostatic Precipitator - dust

8 samples of 1 hour duration at 1 cfm

Grams precipitate net - range 0.0012 - 0.0055

Average = 0.0038 or 2.2 milligrams/cu. meter

2 samples of 1 hour duration at 3 cfm

Grams precipitate net - range 0.0029 - 0.0038

Average = 0.0034 or 0.7 milligrams/cu. meter

Continuous air filter - dust

10 samples of 1 hour duration at 1 cfm

Grams precipitate net - range 0.0032 - 0.0073

Average = 0.0048 or 2.8 milligrams/cu. meter

Reflectance Readings

Range 62 - 73 per cent

Thomas Autometer

SO_2 range - 0.03 - 0.09 ppm - average 0.06 +

A survey for fluorides was made with 65 sampling stations (mostly in the industrial area). No measurable amount of fluoride was found(37).

Conclusions of the study were as follows:

1. Seattle is involved in both local and regional air pollution

problems.

2. Its principal pollutant is smoke, though damages result locally from other pollutants.

3. Meteorological conditions are an important factor in producing both of these problems.

4. Topography has an important effect through concentrating industry in specific locations and in influence in local wind directions.

5. The Seattle smoke problem divides itself naturally into three groups based on whether the fuel used is wood, coal, or oil. Adequate engineering advice is available in Seattle for consultation by plants or persons having difficulty in burning these fuels smokelessly.

6. The average dust fall of 27.5 tons per square mile per month equals that of Los Angeles even though Seattle's industrial density is much less. The production of this dust fall can be appreciably reduced by an adequate ordinance properly administered. Highly concentrated dust falls occurring locally also can be greatly decreased.

7. Appreciable quantities of black smoke are contributed by ships and switch engines. These can be controlled by appropriate methods. The suggested remedy for the latter is to substitute diesel engines for coal or oil burners as is being done in some cities.

8. Seattle receives appreciably less sunlight than does the Seattle-Tacoma Airport, and consequently a greater percentage

decrease in ultraviolet radiation occurs. Since Seattle has only 4.56 hours of sunlight per day as an average or 36 per cent of the possible sunlight, the importance of reducing air pollution with its interference to what sunlight Seattle does get is obvious.

9. The principal cause of the existence of an air pollution problem in Seattle is the general lack of concern on the part of industrial plant owners over this problem.

LOCAL CONTROLS AND ACTIVITIES

There is no formal control program. The Seattle Air Pollution Control Board, comprised of representatives of the City Council, City Engineering, Health and Building Departments, and Planning Commission, is advisory. It is presently active in promoting local and state legislation. It receives and acts on complaints by referral to appropriate departments. Investigation of complaints is made followed by suggestions for voluntary correction.

In the first 10 months of 1956, 37 complaints were received of which 25 were handled by the Building Department, 4 by Engineering, 2 by Health, 1 by the Board staff and no action on 5 for lack of adequate information. The Board is not geared to carry on an extensive program so no effort is made to invite complaints. The nature of all complaints was similar -- smoke, dirt and ash.

The Board is presently planning a public information program.

Seattle established a network of stations for dust fall determinations starting in the spring of 1954. The network consists of 28 stations of which 9 are in the industrial areas. The results summarized through May of 1956

Seattle (Cont'd.)

in tons per square mile per month are as follows:

	Residential Zones	Industrial Zones	Average for City
1954			
August	16.29	18.36	17.68
Sept., Oct., Nov.	18.76	32.75	23.61
1954 - 1955			
Dec., Jan., Feb.	20.28	40.21	26.69
Mar., Apr., May	24.92	48.46	32.04
June, July, August	18.08	28.56	17.96
Sept., Oct., Nov.	23.01	41.21	28.46
1955 - 1956			
Dec., Jan., Feb.	21.36	41.24	27.72
Mar., Apr., May	26.25	42.85	31.65
22 Month Average	21.8	38.3	26.5

The residential stations are well distributed over the city. The industrial stations were selected to cover the Interbay-Ballard-Lake Union or north end industrial area and the south end industrial area. One station in the heart of the south end industrial area averaged 83.5 tons per square mile per month with a minimum and maximum of 51.2 and 136.8, respectively for any single month period.

The tabulated results indicate a difference between residential and industrial zone, but it is believed that they should not be interpreted as specifically accurate because representative sampling is difficult to obtain. Comparing results at one city with those at another requires complete knowledge of both the sampling programs. With this word of caution, typical results at other cities are shown below:

City	Year	Dustfall** Tons/Square Mile/Month
New York*	1951 - 1955	63.8
Cincinnati*	1950 - 1956	22.3
Pittsburgh*	1951 - 1953	51.1
Detroit*	1951 - 1953	58.0
Seattle***	1950 - 1951	27.5
	1950 - 1951 (Industrial Zone)	53.1
Seattle***	1954 - 1956 (22 Months)	26.5
	1954 - 1956 (Industrial Zone)	38.3
Tacoma(19)	1954 - 1956 (18 Months)	12.8
	1954 - 1956 (Industrial Zone)	18.3

* Source: Annual reports of the respective cities
** Average over city except where indicated
*** Different sampling network used in these two series

SUMMARY

Air pollution levels in Seattle are such that careful consideration may indicate the need to establish a program for the preservation of the air resources. In view of existing meteorological and topographical conditions and the anticipated rapid growth of the Seattle area (accompanied by increased pollution emissions), considerably higher atmospheric pollution levels would be expected unless something is done to restrict pollution emissions. Domestic and commercial heating adds a significant contribution. Automobile exhaust emissions, while their effect is difficult to estimate, are considered a very real part of the total. Industrial process emissions are present primarily in the form of dusts and cinders resulting in local heavy dirtfall, while poor combustion with wood, coal, and oil fuel are evident

Seattle (Cont'd.)

in many instances. Natural gas should be of benefit in many cases where obsolete equipment or poor combustion controls exist.

The City and other public bodies should take note of their own contribution, such as the emissions from the City asphalt plant and burning dumps, and the Public Safety Building.

The industrial expansion to the south presents an increasing problem unless civic and industrial officials plan wisely.

Seattle is a major contributor to the regional air pollution problem.

TACOMA

GENERAL DESCRIPTION

Tacoma is the second largest city in Western Washington and the third largest in the State.

Pertinent statistics include:

Population 1940 - 109,408
1950 - 143,673
1956 - 156,700 (July estimate)

Area - 48 square miles
Population Density - 3261 persons per square mile

Located on lower Puget Sound, it has excellent access to water transportation. The development of industrial sites and docking facilities together with rail facilities has made it a major industrial city. It is a business and commercial center for numerous neighboring towns and a substantial suburban area as well as serving Fort Lewis (Army), McChord Field (Air Force), and the Mt. Rainier Ordinance Depot. Industrial activity is centered along the tidewater area northeast of the city where filled land and man-made waterways provide for substantial industrial growth.

Residential areas and growth are to the south, west and east. Ruston, a small industrial town with a population of 735, is situated in the northwestern sector and is surrounded on three sides by the corporate limits of Tacoma and on the north by tidewater. It contains a large copper smelter.

TOPOGRAPHY AND CLIMATOLOGY

Tacoma, on southern Puget Sound, is bounded by Commencement Bay to the northeast and the Narrows to the west. The peninsula, Point Defiance, forms its northwestern extremity. From tidewater the land rises abruptly to approximately elevation 200 and then slopes gently up to elevation 400 in the southerly portions. The Puyallup River Valley enters from the east and broadens to some three miles in width as the River enters Commencement Bay. The industrial area is located in this low, broad valley. A saddle is formed in the south-central sector at elevation 250 and contains a secondary industrial area and rail yard. To the south and east are rolling hills up to elevation 500 except where they are interrupted by the Puyallup and Green River Valley system.

Located between the Cascade Mountain Range to the east and the Olympic Range to the northwest, Tacoma is sheltered from cold continental air, but is exposed to the southwest winds during the eight months of the heating season. The southwest winds will carry industrial pollutants away from the city and accumulate them in the adjacent valley system. Rarely are winter winds expected to be from the northerly quadrant.

During the summer the proximity of the Sound produces land-and-sea breezes resulting in light, variable winds at night, becoming northerly during the day. These light northerly winds result in drifting of the pollutants over the City and into the Puyallup Valley. Tacoma is exposed to pollution from Seattle when a northerly wind pattern exists. With southerly winds it may contribute to the general atmospheric pollution over the Seattle area.

Stable air conditions are estimated to occur about six times during the winter and may persist up to several days duration. Summer nocturnally stable air is usually broken before noon.

POLLUTION SOURCES

Transportation - Railroad movements are approximately as follows:

500 diesel-electric unit miles per day on passenger and freight trains

48 coal-steam unit miles per day on freight trains

270 diesel-electric switch engine yard hours per day

4 oil-steam switch engines

Total fuel consumption by diesel-electric units is estimated to be 3100 gallons per day.

The contribution by the diesel-electric units both on through trains and operating as switch engines is considered minor. The coal-steam freight locomotives and the oil-steam switch engines are a more serious problem. The company operating this coal and oil-steam equipment reports that replacement with diesel-electric will probably be completed by the end of 1957.

Shipping activity, of 1000 net registered tons and over, at Tacoma is estimated to average 675 - 700 vessels annually. In addition are military craft, smaller commercial boats, and pleasure boats. No serious problem is expected from this source except for local nuisance in those cases of fire-up after a lay-over period. Excessive smoke will often occur under this circumstance.

Passenger vehicle mileage is estimated to be 1,510,000 miles daily for an "average maximum" day. The approximately 102,000 gallons of gasoline consumed daily would produce the following emissions:

Tacoma (Cont'd.)

Pollutant	Tons per Day
Hydrocarbons	20
Nitrogen Dioxide	4 - 16
Sulphur Dioxide	0.6

Additional emissions include significant quantities of aerosols, aldehydes, organic acids and acetylene.

Domestic, Commercial and Municipal - The business district is served by a central steam plant using oil and hogged fuel. No problem of excessive smoke was reported from this source. The predominant fuel for residential and commercial space heating is oil. It is estimated that 120,000 gallons are burned in residential units on an average day of the eight month heating season. Peak daily use in extreme cold would be much higher. Emissions to the atmosphere would include particulates, hydrocarbons, and oxides of nitrogen and sulphur. Thus a contribution is made to the general atmospheric pollution which is manifested in general dirtiness from particulate fall-out and in reduction of visibility on cold winter mornings under inversion conditions. Hogged fuel is used in three schools and a smoke problem was reported resulting from old poorly operating equipment.

Tacoma has a compulsory garbage collection system. Although burnable refuse is also collected, a number of apartment, commercial and residential incinerators still operate. A smoke and odor problem is present from this source. Garbage disposal is by sanitary landfill. The City still operates a burning dump for rubbish in violation of its ordinance. Located in the industrial fill area, it is a major smoke source. Burning at ground level near a heavily traveled street, it is at times a traffic hazard by virtue of reduced visibility.

Tacoma (Cont'd.)

Industrial Activity - Industrial operations include:

Pulp and Paper Production

Lumber, Plywood, and Wood Fabrication

Copper Smelting

Aluminum Smelting

Ferro-alloys

Steel Fabrication

Metal Casting

Chemicals (Chlorine, Soda, Caustic, Acid, Ammonia)

Flour Milling

Oil Refining (8000 bbl. plant under construction)

Formaldehyde Production (Plant under construction)

Industrial emissions include:

Ferro - Alloys:	Uncontrolled emission of gaseous and solid wastes principally inert silica and carbon. The plant is undergoing modernization including bag-type dust collection for by-product recovery. This should materially reduce the emissions.
Kraft Pulp Mill:	Odorous gases from black liquor burning and from processing. The plant is not a black smoke violator. This plant is particularly active in seeking to solve its problems. Excessive water vapor emission creates visibility problem. Control equipment includes gas scrubbers and electrostatic precipitators for recovery furnaces gases, chain curtain and water scrubbers and sprays for lime kiln gases, and packed scrubbing towers for lime kiln gases. A stainless steel packed oxidation tower for black liquor is under construction. Research on odor control is underway. The management deserves much credit for its efforts.
Stand-by Steam Power Plant:	One of the two plants in particular is a

Tacoma (Cont'd.)

	black smoke problem. During fire-up, several days are required to reach high temperature and good efficiency. Consideration is being given to burning combustible refuse to keep the plant warm. This would also reduce the load at the city burning dump.
Brewery:	Malt odor. No complaints have been received.
Chlorine Plants:	Occasional exhaust of chlorine gas. Reported as a rare occurrence.
Fertilizer Plants:	Dust.
Lumber and Millwork Plants:	Black smoke and cinders from hogged fuel combustion. Wood flour emissions. This is probably the most widespread problem.
Copper Smelter:	Occasional odor and plant damage. Over the years this plant has done much to reduce its contribution. Controls include electrostatic precipitation, SO_2 recovery for acid production, and 563 foot stack. Meteorological control is practiced by oil-fired stack heating to obtain better diffusion under adverse wind and temperature conditions.
Aluminum Smelter:	Fluoride fumes. This problem has been greatly relieved by installing water scrubbers. Observations of atmospheric fluoride and vegetation studies are made routinely by the Western Washington Experiment Station.
Asphalt Plants:	One municipal and one private. Dust emissions. Improvements made at both locations. Recent stack samples indicate that the municipal plant is the worst offender although its location is remote.

Tacoma (Cont'd.)

PREVIOUS STUDIES

A 1948 study(2[illegible]) by the University of Washington investigated residential fuel usage, climatology with respect to local wind patterns, railroad activities, combustion equipment and practices, industrial processes, and black smoke emitters.

Fuel use distribution was estimated as follows:

Type of Heating	Number of Residences
Oil (Furnace and Circulators)	23,000
Wood (Furnace and Circulators)	10,000
Coal	10,000
Gas (Manufactured and LP and electric heat)	3,732

A map of the area with a transparent overlay showed the wind direction, frequencies and the area of effect from industrial pollution sources.

Detailed investigations were made of processes in 49 industrial plants. A review of each condition and problem was made, and in some cases, improvements were proposed.

The study reviewed the conditions for obtaining satisfactory combustion. Ringleman observations were made and numerous black smoke emitters located although the observations were made over too short a time to be statistically conclusive.

It was found that Tacoma air pollution included:

1. Smoke, cinders, and fly ash
2. Chemical dusts
3. Fumes and odors

Tacoma (Cont'd.)

It was also determined that the smoke was produced, in order of increasing importance, by:

1. Residential furnaces
2. Railroads
3. Industrial plants

The conclusions were:

1. The Tacoma smoke originates not only from the burning of hogged fuel but also from incomplete and improper combustion of coal and oil.
2. The major source of smoke is the incomplete combustion of hogged fuel and miscellaneous wood wastes.
3. The smoke production arises in part from a lack of knowledge on the part of some operators as to methods for securing clean combustion with wood wastes, and in part from a commonly accepted view that the furnace is a necessary evil to be put up with as the source of power for the plant and to be maintained at the least possible cost. It is felt that money spent on its refinement does not bring in additional profits or increase production.
4. Wood wastes can be burned with the production of very little or no smoke.
5. The reconstruction needed to produce smoke-free combustion is, in most plants, relatively inexpensive. Such modifications should, however, be carried out under competent supervision or advice.
6. A surplus of wood wastes is produced in Tacoma and at present is disposed of by burning in the crude burners long used at lumber mills. Such burners produce considerable smoke though of less density than that produced at many plants using this material as fuel.

7. The burners should be eliminated. To do this, either more satisfactory burners must be developed or markets found for utilizing this waste.
8. Electrostatic or supersonic precipitators are too expensive in installation costs for most of the plants under consideration. Methods that are economically feasible, include (a) the admission of secondary air in proper amounts and locations, (b) the use of batteries of small cyclones to remove the carbon particles in the smoke which are returned to the furnace and burned, and (c) the economic utilization of these wastes as in the rapidly growing soft and hard board industries, and in the production of sugar, alcohol, food yeasts, and other marketable products.
9. Smoke from coal-fed furnaces can be controlled by (a) the use of adequate quantities of primary and secondary air applied at proper points and with the production of desirable turbulence, (b) the proper design of all furnaces to be built hereafter, (c) the use of coal having specified limitations on volatiles as stated in the proposed ordinance dealing with solid fuels, and (d) the construction of additional boiler capacity where existing plants are being forced beyond their efficient operating range.
10. Locomotive smoke can be prevented by proper over-fire ventilation. Part of the present smoke results from the blowing of flues, a necessary part of the procedure for cleaning said flues economically. Existing conditions would undoubtedly be considerably bettered if such flue-cleaning were either done outside of the City Limits, or perhaps in the Tide-Flat area, and limited to a maximum of say, ten minutes.

Tacoma (Cont'd.)

Local Controls and Activity - On the basis of the 1948 report(26) and as promoted by the Tacoma Engineers' Club and Chamber of Commerce, an air pollution ordinance was adopted in 1950. The latest revision, Ordinance No. 15223, January 1955:

1. Provides for controlling emissions of dusts, gases, odors, and smoke, and regulates the use of equipment emitting cinders, dusts, fumes, odors, soot and smoke;
2. Provides for an Air Pollution Control Engineer in the Department of Public Works and establishes a Board of Appeals consisting of
    1 member representing industry management
    1 member representing railroads
    1 member to be a merchant
    2 members chosen at large
3. Provides for operating licenses and fees for various classes of equipment over 200,000 Btu per hour;
4. Prohibits certain emissions and establishes measurement standards -
    a. Maximum smoke tolerance, No. 2 Ringelmann except for maximum of No. 3 for 3 out of 15 minutes during fire-up or cleaning (9 out of 60 minutes for locomotives while firing or cleaning and 3 out of 15 minutes in normal operation).
    b. Maximum dust tolerance 0.85 pounds per 1000 pounds of gases adjusted to 50 per cent excess air or a dust removal device with efficiency of not less than

85 per cent (75 per cent if constructed prior to date of ordinance).

c. No objectionable materials constituting a nuisance;

5. Provides for entrance and inspection, notices of violation, sealing of equipment after 10 days notice, immediate sealing of equipment during emergency confirmed by Director of Health, and appeals;
6. Provides prosecution and penalties.

The program consisted of education and investigation for three years, no action for one year, and finally a one-man operation since 1954. Since 1954 a great deal has been accomplished considering that one man was charged with the entire responsibility.

Surveys in December 1954 indicated:

Sources of Black Smoke

40 total industrial sources

500 (approx.) residential sources observable at any instant

75 (approx.) commercial and 13 public sources observable at any instant

Sources Affecting Visibility (other than black smoke)

8 industrial sources

6 public sources

Residential and Commercial incinerators and 40 open fires

Sources Damaging Vegetation

2 industrial

Sources Constituting Nuisances (odor or irritants)

6 industrial

Tacoma (Cont'd.)

6 public (garbage dump, fire in abandoned fill, 4 sewer outfalls)

Numerous backyard incinerators and open fires

Sources Emitting Toxic Material

Industrial plants emitting SO_2, chlorine and fluorides

Other emissions including CO, auto exhausts, sewer gas, hydrocarbons, and insecticides

(No official evidence available as to the actual existence of health problem)

Complaints in 1954-1955 were classified as follows:

Nature of Complaint	Number of Complaints	
	1954	1955
Soiling	27	22
Personal Health	17	5
Damage to Vegetation	6	5
Nuisances	20	24

Technical studies initiated in 1954 included ~~dirt~~ dust fall collections, spot samples and visibility records (by photo). An 18 months record (1954-1956) shows the following dust fall concentrations in tons per square mile per month.

Total City Average	12.8
Industrial Zone	18.3

During 1955, a number of improvements in black smoke and odor reduction were accomplished by industry through operational changes or new equipment. One plywood mill installed a completely new boiler plant utilizing hogged fuel with excellent results. Unfortunately these improvements were largely offset by new plants or plant expansion and the increased burning on the city fire dump.

Tacoma (Cont'd.)

The year 1956 brought an increased emphasis on ordinance enforcement and sampling studies.

SUMMARY

The factors incident to the air pollution problem in Tacoma are well established as a result of the 1946 study and the aggressive approach made by the Air Pollution Control Engineer in the last two years. Much improvement has been accomplished. The larger industries, for the most part, have utilized available modern methods of control. Smaller industries may find their problems more difficult financially, but practical control methods are known.

The valley industrial location limits diffusion of pollutants into the atmosphere resulting in frequent restricted visibility. This, together with pulp mill odors, give Tacoma an undesirable reputation for air pollution. However, dirt fall records, except in an isolated instance (now being corrected), do not indicate a problem as severe as appearances suggest.

The valley location with the accompanying problem dictates a need, however, for understanding and cooperation among City and Port officials and industry (present and future) as to the need for air pollution control. On this basis, air pollution and the desire for industrial expansion need not be in conflict.

Public education should be continued and expanded. Residential and commercial heating systmes should be brought and kept up to efficient operation. Refuse incineration practices should be improved or else halted. Early conversion from steam to diesel-electric locomotives should be encouraged.

Tacoma (Cont'd.)

The City and other public bodies should take note of their own contribution. For example, the open burning dump and inefficient school heating system are not in keeping with the spirit of the air pollution control program.

EVERETT

GENERAL DESCRIPTION

Everett, located on Puget Sound 30 miles north of Seattle, is an industrial city and the commercial center for much of Snohomish County. Pertinent statistics include:

Population	1940 - 30,224	
	1950 - 33,849	
	1956 - 34,300	(July estimate)
Area		- 10 square miles
Population Density		- 3430 persons per square mile

There is an additional 15,000 population within a few miles south of the city.

TOPOGRAPHY AND CLIMATOLOGY

Everett is located on a north-south neck of land 4-1/2 miles long and varying from 1-1/2 to 2-1/2 miles wide. It is bounded on the east and north by the Snohomish River and on the west by Possession Sound. The land rises abruptly on three sides from sea level to over 100 feet in the main business district. To the south the land slopes up to over 500 feet.

The residential area is on the north and south, with new expansion to the south. The industrial area forms a belt around the three water sides, north, east and west. To the east and southeast is the low broad Snohomish River Valley. To the north is a low broad valley encompassing Marysville and continuing northward some 12 miles.

The wind characteristics follow the general pattern for the Puget Sound region. Summer winds are usually from the northwest. Winter winds are generally from the south. Calm periods occur three to four percent of the time, with a maximum of eight percent in October and November. Winds are generally favorable for dispersing pollution. Exceptions are the light northerly summer winds which carry emissions into the city. On occasions, pulp mill odors are noticeable, especially during periods of stable air and fog.

POLLUTION SOURCES

Transportation - Railroad activity is as follows:

490 diesel-electric unit miles per day - passenger and freight
104 diesel-electric switch engine yard hours per day
24 coal-steam switch engine yard hours per day

The diesel-electric units consume about 1785 gallons of fuel per day within the city. These are not considered significant contributions to air pollution. On the other hand, the operation of the coal-steam switch engines are a likely source of heavy smoke, soot, and ash. It is expected that they will be replaced in 1957.

Water transportation is light, with a probable maximum of 180 ships per year (1000 net registered tons and over).

Vehicles are estimated to consume about 360,000 gallons of gasoline in an average maximum day. The resulting emissions would be:

Pollutant	Tons Per Day
Hydrocarbons	72
Nitrogen Dioxide	14 - 29
Sulphur Dioxide	3

Significant amounts of aerosols, aldehydes, organic acids and acetylene are also emitted.

Everett (Cont'd.)

Domestic, Commercial and Municipal - The predominant heating fuel is oil. Residential oil use is estimated to average 30,000 gallons daily during the eight month heating season. The total requirement, including commercial, may reach 50,000 gallons. The amount of heavy oil used by one large pulp mill would be nearly twice the amount of light oil used for space heating. An unknown amount of coal and wood is used.

Refuse and garbage disposal is by open burning and is a source of smoke and odor.

Industrial Activity - The major industrial operations include:

Pulp and paper production

Lumber, plywood, shingle and wood fabrication

Fish freezing and canning

Dairy products

Iron works - heavy industrial equipment

Concrete products

Fish and meat by-product and rendering

Industrial emissions include:

Pulp Mills - Of the four mills, two are located on the west waterfront, one at the north and one southeast in the Snohomish Valley at Lowell. Most of the time winds are sufficient to disperse pollution. Odors tend to permeate the city and drift into the nearby valleys during periods of light northerly winds in the summer and stable periods (particularly with fog) in the late fall. Modern control equipment and practices common to the industry such as SO_2 condensers and absorption towers, waterspray in lime stacks, combustion controls, etc. are in use. Without these the condition would be unbearable. Three of the mills are switching to natural gas to replace all or part of their oil fuel.

Everett (Cont'd.)

Lumber Mills
Shingle Mills
Plywood Plants - Smoke and cinders from hogged fuel boilers and wood waste burners are still a problem in many mills even though most plants have or are installing combustion controls and cinder arrestors of one kind or another. The most severe problem is from the waste wood burners. Fortunately a large amount of wood waste and chips are now sold to pulp mills for use as fuel or pulp. With the large pulping capacity this practice is expected to increase.

Rendering Plant - This has been an odor problem particularly to residents to the north in the vicinity of Marysville.

There is some indication that one or more oil refineries may be constructed in the Everett area. Such development presents no serious problem if modern air pollution controls and practices are used. Site selection in terms of meteorological factors, however, should not be neglected.

PREVIOUS STUDIES

A study in 1954 (27) demonstrated the effect of uncontrolled emissions of SO_2 from a pulp mill. A number of residents complained of plant damage and expressed concern for their health during the period June through September when the northwest summer winds carried emissions onto the bluff overlooking the mill. The survey showed excessive SO_2 concentrations ranging from 1 to 25 ppm on grab samples. (One-half ppm was considered injurious to vegetation and 10 ppm creates severe throat irritation.)

The condition lasted until October when the winds changed. Subsequently, corrections were made by the company. During the period, the company was making a major conversion and had one SO_2 absorption tower out of service.

This incident is significant in two ways:

1. It demonstrated the severe condition that could exist without plant controls.
2. It demonstrated that controls and processes are available and are in general use by the pulp industry by which such problems are minimized or largely overcome.

LOCAL CONTROLS AND ACTIVITIES

There are no local ordinances relating specifically to air pollution. There is apparently no local program in air pollution control nor any routine means for handling and investigating complaints.

SUMMARY

Transportation, domestic and commercial activities are about normal for a community of this size. Vehicles and ships do not contribute in any significant degree to air pollution nor does the rail activity with the exception of coal-steam railroad switch engines. Smoke from space heating units, both residential and commercial, although not considered serious, justifies a local educational program for better combustion practices.

Everett, surrounded by pulp and lumber products industries, is subject to serious odor problems and to cinders and smoke under certain meteorological conditions. The cinders and smoke can be controlled by proper combustion equipment and practices. The odor problem is yet to be solved by the pulp industries nationally. As evidenced by one incident of vegetation damage and human discomfort accompanying high concentrations of SO_2, the importance of proper control equipment and practices in the pulp industry is shown to be a vital necessity.

SPOKANE

GENERAL DESCRIPTION

Spokane is the major city in the Inland Empire and is located about 25 miles from the eastern border of the State. Pertinent statistics include:

Population 1940 - 122,001
1950 - 161,721
1956 - 186,000 (July estimate)
Area - 41.5 square miles (incorporated)
Population Density - 4500 persons per square mile

It is a major business and commercial center for the Columbia Basin, the Palouse wheat belt and the timber and mining regions of northern Idaho and northeast Washington. The greater Spokane area extends east in the Spokane River Valley to Velox, north to Mead, and west to Fairchild adding some 90 to 100 square miles. In the eastern valley sector are industrial and agricultural enterprises interspersed among residential areas and small communities. To the north are residential areas and several industrial areas. To the west are Geiger Field (municipal) and Fairchild Air Force Base. Residential and industrial growth is to the north and east.

TOPOGRAPHY AND CLIMATOLOGY

Most of Spokane and its industrial environs are located in a broad valley system at a general elevation of 2000 feet. This valley system is a controlling factor in the wind pattern, particularly at low velocities.

The Spokane River enters from the east and passes through the heart of the city. It exits on a northwesterly course. The land rises sharply from downtown

Spokane (Cont'd.)

at elevation 1900 to the south and west residential areas, elevation 2200, within a one mile to elevation 2200. This rim of hills is breached at the southwest corner of the city by the deep narrow Latah Creek Valley at elevation 1800.

To the north the land slopes more gently through a residential area to a broad valley at elevation 2000. In this valley and some six miles from the downtown area are located a ferro-alloys plant and an aluminum reduction plant. East of the city the Spokane River Valley increases in width to about five miles. Major industries in this area are a sulfite paper mill, a cement plant, and an aluminum rolling mill. The valley extends to the state line at elevation at elevation 2000 and continues eastward to Coeur d'Alene Lake in Idaho (elevation 2124). The valley walls rise to over 3000 feet on either side.

Mt. Spokane rises sharply to elevation 5881, 22 miles northeast of the city. Mica Peak rises to elevation 5205, 15 miles southeast of the city.

Local wind and inversion pattern data at the U.S. Weather Bureau at Geiger Field were studied in 1951 by the State College of Washington.(28) The following summary is based on that study. The prevailing air flow is from the south to southwest sector. A secondary flow is from the north to northeast sector throughout the year with a slight predominance from September through December. The winds in the narrowing valley to the north of the city are modified to a north-south flow by the local topography. The predominant direction for winds of less than eight miles per hour is northeast and is of a diurnal character. These low velocity northeasterly winds persist the year around and are of major importance in the study of air pollution. Such air drainage phenomenon carries pollutants from the industrialized section located to the north and east of the city into many of the residential and business areas. This drainage affects the micrometeorology of the area. Stable air ~~(temperature inversion)~~ conditions often develop in the valley which prevent the normal upward dispersion of pollutants. The records for the five-year period, 1944 to 1949, show that the maximum frequency of temperature inversions occurs during the winter season when domestic and commercial space heating systems are in operation.(28) The frequency of days with temperature inversions below 2000 feet was reported to range from 8 per month in June up to 20 in January and October.

Several observers have noted the early morning accumulation of pollutants in the vicinity of Coeur d'Alene Park. The park is located on the west side of the city near the junction of the Spokane River and Latah Creek. This condition is attributed to the concentration of community pollutants in the low valley junction as a result of nocturnal air drainage, together with the automobile exhaust accompanying the heavy early morning traffic in this vicinity.

POLLUTION SOURCES

Transportation - Railroad activity is approximately as follows:

1081 diesel-electric unit miles per day on passenger and freight trains

500 diesel-electric switch engine yard hours per day

The total fuel consumption by diesel-electric units is estimated to be about 6000 gallons of fuel per day. This is a relatively small amount particularly since diesel-electric units are considered clean burning. Likewise, Spokane is fortunate in having diesel-electric switch engines. Occasional local momentary smoke nuisance may occur with inefficient operation of switch engines.

Vehicle mileage is estimated to be about 1,450,000 miles for an average maximum day. The nearly 100,000 gallons of gasoline consumed each day would produce the following emissions:

Spokane (Cont'd.)

Pollutant	Tons Per Day
Hydrocarbons	20
Nitrogen Dioxide	4 - 10
Sulphur Dioxide	0.8

In addition, emissions of aerosols, aldehydes, organic acids, and acetylene are significant. These data do not include the built-up fringe areas for which no estimate has been made.

Domestic, Commercial and Municipal - The predominant fuels are coal and hogged fuel. The downtown area is heated for the most part by a central heating plant where coal is used. The lack of excessive smoke demonstrates efficient combustion. Sulphur emissions, however, can be expected. The burning of coal must be recognized as a major contribution to air pollution where obsolete equipment and poor combustion and operation result in smoke, fly ash, and sulphur. Wood contains less ash and sulphur but without proper furnace design, smoke and cinders still constitute a problem. There is a need for determining the fuel types and usage in Spokane before the problem can be properly assessed.

Garbage collection is compulsory. Individual garbage burning is prohibited. Disposal is by municipal incinerator which is reported to operate with very little nuisance. Except for the burning of leaves and brush in the fall, refuse disposal does not appear to be an air pollution problem.

Industrial Activity - The major industrial operations include:

Aluminum Smelting and Rolling

Pulp and Paper Mill

Lumber and Wood Fabrication

Ferro-alloys

Metal Fabrication, Founding and Machinery

Spokane (Cont'd.)

Meat Packing and Food Processing

Flour Milling

Cement Manufacture

Industrial emissions include:

Aluminum Smelter	- Moderate damage. Formerly extensive pine damage. Five miles north of city limits. Modern dust controls and scrubbers have considerably reduced damage area.
Ferro-alloys	- Copious fumes released. Two miles north of city limits. Dust collection on crushers and grinding mills. Natural gas now used for fuel.
Aluminum Rolling Mill	- Smoke emissions from the oil-fired remelt furnace. Six miles east of the city limits in Spokane Valley. Substitution of natural gas is planned which will relieve this problem.
Meat Packing and Rendering	- Complaints received on odors. Rendering plant has water spray for odors. No controls indicated on others.
Cement Plant	- Minor complaint of H_2S odor and dust in the immediate vicinity. Located five miles east of city limits. The use of cyclone collectors and electrical precipitators appears to be effective for dust removal. Coal and oil are used for fuel resulting in minor H_2S emission. Natural gas will be used and this should eliminate the odor problem.
Smoke Sources	- Numerous excessive smoke sources were observed including dairies, breweries, laundries, and public buildings.
Pulp Mill	- No problem reported. Three miles east of city limits. SO_2 is discharged. Cinder collector installed on hogged fuel burner.

A proposed installation for mining and processing lightweight aggregate was rejected by the city and county planning Commission because it would constitute a nuisance and an air pollution problem.

Spokane (Cont'd.)

PREVIOUS STUDIES

The 1951 study mentioned above was preliminary in nature and intended to estimate the types and intensities of air pollution in Spokane.(28) Visibility studies by photographic record were made to demonstrate the effect of pollution concentrated by morning inversions and the subsequent afternoon breakup and clearing. Attention was called to the contribution to the City problem by emissions from the Mead-Hillyard area to the north and the Spokane Valley to the east.

Air pollution sources were roughly classified by types as follows:

Smoke - Inefficiently operating industrial and domestic furnaces using sawdust, hogged fuel and coal.

Dust - From unimproved streets, grinding and mixing operations and the silica dust produced by the electro-metallurgical operation north of the city.

Odors - From chemical process industries and food processing plants in the Spokane Valley.

Gases and Fumes - Sulphur gases from combustion processes. A 2-day (April 5-6) Titrilog record of SO_2 showed maximum concentrations in the early morning hours, 4 a.m. to 8 a.m. with short peaks on the order of 0.8 ppm. This reflects the maximum inversion intensity period, however, space heating was not a major factor as warm weather existed at the time. The contribution of a fluoride source outside the city was noted.

Three air pollution effects were noted.

(1) Reduction of sunlight

(2) Additional dirt and dust

(3) Damage to vegetation

Spokane (Cont'd.)

Two major recommendations were made:

(1) Establishment of an evaluation program to cover dust, sulphur gas, sootiness, visibility, fuel consumption and equipment, and meteorological data.

(2) A committee of civic, industrial and technical leaders on a county-city basis to draw up the basis for an effective program.

In 1955 a study sponsored by the Washington State Air Pollution Advisory Service was initiated but was not completed due to the discontinuation of the program. The preliminary work of the University of Washington Environmental Research Laboratory on this study has been reported.(29) The 1951 report(28) was reviewed and compared to current conditions as to smoke sources, etc. A three-day run was made with two AISI filter tape instruments. Results indicated the effect of an inversion on the third day when a peak of 10.8 COH's per 1000 ft. was recorded compared to a three-day average of 2.4. This is primarily a measurement of smoke. Dust [Dirt] fall jars were set out but the analyses were not completed before the program was discontinued.

The report concluded that air pollution existed in terms of nuisance and public health. It recommended detailed studies before establishing a program and pointed out the role of civic groups, officials, industry, business, trade associations, and citizens in formulating and supporting a control program.

A 1950 study(30) reported on concentrations of gaseous fluorine and sulphur compounds in a pine blight area. The blight area covers some 50 square miles within which a high percentage of pine trees in a three-square mile area were killed. The area is immediately north of and includes portions of Spokane. Within the area were an aluminum reduction plant, a ferro-alloys plant, and a small refinery.

The comprehensive sampling program included a network of 12 stationary sampling stations for sulphur and fluorine (May through September), mobile Titrilog sampling for sulphur compounds operating over 30 locations in October and September, and rain water collectors for sulphate and fluoride analyses at 82 locations in October and November.

Sulphur compound concentrations were considered too low to cause the damage alone, although the effect of sulphur-fluorine mixtures was not established. SO_2 concentrations were well below 0.1 ppm.

The majority of the 1520 air samples for fluorides revealed concentrations of 5 ppb and below. Occasional high concentrations occurred with low wind speeds. The minimum fluoride concentration causing damage was not established.

Rain water sampling pinpointed the major fluorine source to the center of the damage area. The sulphur pattern, however, showed the effect of sources outside the damage area of all types common to cities.

LOCAL CONTROLS AND ACTIVITIES

There are no air pollution or smoke ordinances. The new zoning ordinance, however, takes cognizance of air pollution. The city has an incinerator ordinance and garbage burning is prohibited. Complaints are handled by the Health Department or Fire Department depending upon the nature of the complaint. No organized control activity exists. The problem has, however, been of sufficient concern that several brief studies have been inaugurated.

SUMMARY

Air pollution exists in the Spokane area. Except for the specific case of pine damage (now partly remedied), it is primarily of a nuisance type. Industrial smoke and dust are apparent. Commercial and residential heating (largely by coal and wood) make up a large proportion of the general pollution. The use of natural gas will reduce the problem. This will be most apparent in industrial areas where the transfer will occur over a relatively short period of time. Meteorological conditions are frequently favorable for the development of stable air conditions, particularly during the winter heating season.

BELLINGHAM

GENERAL DESCRIPTION

Pertinent statistics concerning Bellingham include:

Population 1940 - 29,314

1950 - 34,112

1956 - 36,100 (July estimate)

Area - 22 square miles

Population Density - 1640 persons per square mile

The predominant recent growth factor has been the construction of a large oil refinery at nearby Ferndale some 12 miles to the northwest. A dramatic growth increase is not expected unless a new major industry settles here. This possibility is enhanced by the availability of Canadian crude oil. Historically, the major industries have been in lumber, coal mining and fishing. There is considerable undeveloped area as indicated by the low density of population.

TOPOGRAPHY AND CLIMATOLOGY

The city is located on the east side of Bellingham Bay which is four to five miles wide and sheltered on its west side by Lummi Island rising to over 1500 feet. The city is exposed on its south-southwest perimeter to relatively open water while to the north extends the broad Nooksack Valley lowland. The mountainous eastern segment with the Cascade Range in the background affords good protection against invasions of airmasses from the east. Within the city elevations vary from the industrial belt at tidewater and 25 to 50 feet elevation in the business district to elevations of 100 to 300 feet in the north, east and south residential areas with extremes of 600 feet to the south.

Bellingham (Cont'd.)

The winds at Bellingham follow the southerly characteristic typical to Puget Sound. Further north (i.e. Vancouver, B. C.) easterly winds predominate reflecting the effect of the Frazer River valley. From April through September, winds are mostly south to southwest with few winds over 10 mph and calm winds from 15 to 20 percent of the time. Southwesterly winds will carry industrial emissions into the business district and north residential area. From October through March, the wind direction is quite variable with winds over 10 mph, but is mostly from the southeasterly. Occasional high winds from the north have been experienced in January. Moderate to strong northerly winds will carry emissions into the southern residential area but and will usually afford favorable dispersion; however, during periods of calms and stable air, emissions can be expected to remain in the city.

POLLUTION SOURCES

Transportation - Railroad movements were determined as follows:

25 diesel-electric units per day through passenger and freight trains

3 diesel-electric switch engines, 40 locomotive yard hours per day

The total fuel consumption is estimated to average 510 gallons of diesel oil daily. The contribution by this relatively small amount of fuel is considered negligible. However, inefficient combustion, particularly by the switch engines, causes a local smoke nuisance of short duration.

Vessel movements are relatively light -- probably not exceeding two per week for ships over 1000 net registered tons. In addition are local tug boat and mail-freight vessels. Except for localized nuisance during fire-up periods from ships laying over in port, no significant problem exists.

Bellingham (Cont'd.)

Passenger vehicle mileage is estimated to be on the order of 8.1 million annual average. For an average maximum day of 340,000 vehicle miles, the fuel consumption is taken as 23,000 gallons. The resulting emissions would be:

Pollutant	Tons Per Day
Hydrocarbons	4.6
Nitrogen Dioxide	1 to 4
Sulphur Dioxide	0.2

In addition, emissions of aerosols, aldehydes, organic acids and acetylene are significant.

Domestic, Commercial and Municipal - Fuels used include oil, wood (sawdust) and coal. Natural gas service will soon be available. The local coal mining industry has been closed down and some conversion from coal can be expected. No estimate of the proportion of various fuels has been made; however, the emissions from 9,000 to 10,000 homes together with the commercial and institutional heating systems can be expected to add a substantial amount to air pollution by way of smoke, soot, fly ash, hydrocarbons, and oxides of nitrogen and sulphur.

Garbage collection is compulsory. The operation is handled by contract between the city and a private contractor. Considerable burnable refuse is also collected. Until recently, disposal by burning at a site on the industrial waterfront was practiced but this resulted in numerous complaints of smoke and odor. Burning is not practiced at present with the result that the nuisance from this source is much reduced.

Industrial Activity - Industrial operations include:

Bellingham (Cont'd.)

Pulp and Wood By-Product Recovery

Paper Mill

Lumber and Wood Fabrication and Treating

Plywood Plant

Cement Manufacture

Boat-Building (Wood, Steel and Fiberglass)

Fish Canning and By-Products

Food Processing

Dairy Products

Steel Fabrication and Iron Works

(The coal mining industry is presently inactive)

Bellingham is not classed as being heavily industrialized. Predominant manufacturing payrolls are in the pulp and wood products, cement manufacturing, and boat-building. The fiberglass boats and plastic luggage industries are growing. Fish and food processing is seasonal.

Industrial air pollution noted includes:

Sulphite pulp mill fumes and odor - Moderate to heavy depending on wind and air stability. The plant location is within a few blocks of the business district. Plant controls include absorbers or water scrubbers on units venting chemical gases; cyclones for fly ash and cinder removal; and water scrubbers for dust removal from spray drier stacks.

Cement dust - Moderate
Plant located northwest of city in sparsely populated area. Controls include cyclone and cloth type dust collectors. Natural gas planned to replace fuel oil.

Odors from fish reduction - Moderate to light.

Smoke and dust generally from industrial power plants, gravel and cement products plants, waste burners, etc. - moderate to light.

LOCAL CONTROLS AND ACTIVITIES

There have been no past studies and there is no established control program. Complaints are usually referred to the health or police departments depending upon the nature of the complaint. Follow-up and investigation may result in correction if a nuisance or health hazard is established.

SUMMARY

Winds are generally favorable for dispersal of pollutants. Occasional light winds and stable air conditions allow industrial emissions to accumulate over the city. The pulp mill discharge is the principal source of effluents; railroad and vessel activity is of minor concern.

Automobile emissions have been estimated, but their significance is not established. Residential and commercial heating plants add their share of pollution during the heating season.

PORT ANGELES

GENERAL DESCRIPTION

Port Angeles is a coastal city located on the northern side of the rugged Olympic Peninsula and on the shores of the Strait of Juan de Fuca. Pertinent statistics include:

Population 1950 - 11,233
1956 - 11,900 (July estimate)
Area - 5.45 square miles
Population Density - 2180 persons per square mile

There are approximately 2000 more people living south of the city limits. Its basic economy is in lumber and wood products.

The city is stretched out along the waterfront with the industries at the water's edge. The main street is adjacent to and inland from the industries, and the residential areas are located on the slopes and bluffs. On Ediz Hook, a long narrow spit of land extending out into the Strait and curving to the east, are located several of the wood products industries. The city is currently actively encouraging industry to come in and has recently completed a hydraulic fill along the waterfront as an industrial site.

TOPOGRAPHY AND CLIMATOLOGY

Immediately to the south the mountain peaks in the Olympic National Park rise to elevations of 6000 to 8000 feet. At Port Angeles shoreline bluffs are slashed by three north-south ravines.

The climate of Port Angeles and immediate vicinity is influenced chiefly by the flow of marine air from the west through the Strait of Juan de Fuca and over the Olympic Mountains to the south. In the spring and summer months the wind is almost entirely from the west. In the fall and winter months it may be easterly as well as westerly. The summer west winds usually subside to near calm conditions during the nights with the subsequent development of low cloud layers which usually persist until noon of the following day.

In the winter and early spring months there are low pressure systems continually moving inland off the Pacific Ocean. Winds associated with these systems often cause westerly winds to exceed 35 mph in the Strait.

The storm fronts of the fall, winter and spring months account for most of the precipitation. Most of the cloudy days occur in the winter. Most of the fog occurs in late August and September. This fog is mostly a sea type which moves in through the Strait from the ocean. The depth of this fog is often less than one hundred feet above the surface, thus leaving a large section of the city above the fog layer.

The climatology is generally favorable to the City as far as air pollution is concerned. The winds seldom carry the industrial emissions over the commercial and residential areas and calms occur only three percent to seven percent of the time. However, adverse reports and complaints have been received during periods of atmospheric stability.

POLLUTION SOURCES

Transportation - Railroad activity is extremely light with but one diesel-powered freight train making a round trip between Port Angeles and Port Townsend each day.

Shipping activity is similarly light, there being not more than several commercial vessels per week of over 1000 net registered tons. In the summer only, there are six round-trip ferry trips per day across the Strait of Juan de Fuca to Victoria, British Columbia.

Port Angeles (Cont'd.)

It is estimated that automotive vehicles travel about 19 million miles per year within the City and use 5500 gallons of gasoline on an average maximum day. The resulting emissions would be:

Pollutant	Tons Per Day
Hydrocarbons	1.1
Nitrogen Dioxide	0.2 to 0.9
Sulphur Dioxide	less than 0.1

Additional emissions of aerosols, aldehydes, organic acid and acetylene are significant.

Domestic, Commercial and Municipal - The predominant heating fuel for homes, stores, offices, schools, etc. is oil although some electrical heat is used. There are no plans at present for the use of natural gas since it is not probable that it will be piped to this area in the near future. It is estimated that about 4000 homes, eight schools, the hospital and the commercial establishments use about 3,000,000 gallons of heating oil in a year. This combustion will, of course, result in certain emissions to the atmosphere including particulates, hydrocarbons, and oxides of nitrogen and sulphur.

Garbage and trash collection is compulsory and the refuse is hauled to a dump, five miles west of town. Although it is burned, it apparently does not create an air pollution problem because of the general meteorological situation throughout the year.

Industrial Activity - The major industrial operations include:

Pulp Production

Paper Manufacture

Shingle and Shake Production

Plywood Manufacture

Lumber and Millwork

Port Angeles (Cont'd.)

Industrial air pollution at Port Angeles is primarily smoke and fumes from the above listed industries. There are also, of course, the familiar odors from the three sulphite pulp plants. The pollution would appear to be anywhere from light to heavy depending upon meteorological conditions and location in the city.

As previously mentioned, the meteorological circumstances are generally favorable -- sufficient winds from a direction which does not carry the pollution over the residential and commercial areas. However, under adverse conditions, there have been instances of rather severe paint damage to the boats in the yacht harbor, complaints of damage to vegetation, and reports of pollution causing a feeling of nausea to persons living close to a plant.

Industry has reportedly reduced air pollution noticeably. About 1947, certain process changes were made at the pulp plants which reduced the smoke emissions considerably. All three pulp plants have installed equipment to remove waste sulphur dioxide gases. Efforts have also been made to reduce the discharge of particulates from the stacks. However, there is still considerable smoke being emitted from some stacks.

SUMMARY

There have been no previous studies at Port Angeles and there is no established control program. The air pollution potential is apparently reduced because of the favorable climatology of the area and the progressive action taken to control pollution by some industries. The contributions to pollution by transportation, domestic and commercial activities, and refuse disposal appear to be insignificant.

OLYMPIA

GENERAL DESCRIPTION

Olympia, the state capital, is located at the southernmost point of Puget Sound. Together with the city of Tumwater, the total community (incorporated) population is 20,700. Olympia is the commercial center for its contiguous area. It has a sizeable industrial establishment primarily in lumber and wood products. Residential growth is to the east and south. Industrial sites, east, west and south are under consideration. Pertinent statistics include:

Population 1950 - 15,819
1956 - 17,300 (July estimate)
Area - 8.3 square miles
Population Density - 2080 persons per square mile

TOPOGRAPHY AND CLIMATOLOGY

Olympia is located at Budd Inlet. Its primary axis is north to south as is Budd Inlet and on its west side is Capitol Lake formed by damming off part of the original salt water inlet. The industrial area is located on a peninsula extending north from the city. Budd Inlet is from one to two miles wide; Capitol Lake is approximately 1/4 mile wide and extends south to the community of Tumwater a distance of about one mile from the center of Olympia. The business district is at an elevation of about 25 feet while the capitol grounds and residential area are on a hogback at an elevation of 100 to 125 feet and ~~lying~~ lie to the south of the business district. To the west of town, across the lake, the land rises to an elevation of approximately 200 feet in a distance of about

Olympia (Cont'd.)

a mile from Olympia. To the east of town there are several small valleys, and upper elevations do not exceed about 200 feet. The terrain in a northerly direction is made up of a series of salt water inlets and peninsulas with ground elevations generally not exceeding 200 feet. To the south is generally low rolling country for a distance of about 12 miles.

Winds at Olympia are characteristically light and southwesterly with infrequent southerly winds over 30 miles per hour during winter. Nearly equal distribution of light northerly and southerly winds occur during late summer and into September. This indicates that in the summer the north winds in Puget Sound and the southwest winds entering north of the Willapa Hills may "converge" as far south as Olympia. In September, a maximum amount of calm periods (28 percent) occur. Calm periods during the rest of the year vary from 15 percent to 20 percent.

The existence of frequent calms, nighttime inversions with mid-morning breakup and frequent (but very light) northerly winds may help to retain [contain] emissions in the area. At times these conditions cause industrial emissions to drift into the business and residential areas.

POLLUTION SOURCES

Transportation - Air pollution from through trains at Olympia is considered minor. There is, however, excessive smoke from the four oil-steam switch engines operating along the west waterfront. These are expected to be replaced in 1957.

Domestic, Commercial and Municipal - The predominant heating fuel is oil, about 3.5 million gallons being burned annually for residential heating. This is equivalent to about 15,000 gallons per day for the eight months heating season.

Olympia (Cont'd.)

Much of the downtown commercial area is heated by a central steam plant. Although this plant uses the Bunker 'C' oil, observations indicate very efficient combustion controls with no trace of visible smoke. Natural gas is used in the boilers for preheating. In contrast, it has been noted on several occasions that considerable smoke is emitted from the State Capitol heating plant. Excessive smoke was reported at the high school.

Refuse and garbage disposal is at a burning dump two miles west of the city. Although contributing to the general atmospheric pollution, its remote location minimizes the problem.

Vessel movements do not exceed 180 per year of 1000 net registered tons or over. This is not a serious source.

Vehicular traffic accounts for an estimated 12,000 gallons of gasoline consumed for an average maximum day. From this the major emissions would approximate:

Pollutant	Tons Per Day
Hydrocarbons	2.4
Nitrogen Dioxide	0.5 to 2
Sulphur Dioxide	0.1

There are also significant amounts of aldehydes, organic acids, acetylene and aerosols.

Industry - The major industries are in the lumber and wood products group. Plywood manufacture predominates.

Excessive smoke emission has been observed from one large plywood plant. Several waste wood burners, located at mills on the west side of Budd Inlet, are the source of cinder emissions creating a nuisance to the residential area in the vicinity. Most wood-working plants have dust removal equipment.

Olympia (Cont'd.)

Odors are present in the vicinity of the brewery but no complaints were reported.

The U. S. Weather Bureau, in its terminal Forecasting Reference Manual - 1955, lists the major smoke sources in the area as the mills on Budd Inlet, railroad yards of Olympia and east of Olympia, the brewery at Tumwater, and a packing plant southeast of Olympia.

LOCAL CONTROLS AND ACTIVITIES

There is no local air pollution control program. Occasional complaints about the wood waste burners are referred to the fire department. There is an ordinance regulating these burners from the fire protection standpoint.

SUMMARY

Air pollution in Olympia is not serious but is significant at certain times of the year.

The climatological factors are favorable to the city most of the year. In the early fall, light shifting winds, mostly northerly, will carry industrial type emissions into the city. The wood waste burners on the west side of Budd Inlet and the oil-steam switch engines present the most severe problems.

LONGVIEW - KELSO

GENERAL DESCRIPTION

Longview, located adjacent to the large southeastern Washington timber country, is one of the State's major lumber and wood products cities. Almost the entire economy is devoted to lumber-associated industries. Across the Cowlitz River to the east and immediately adjacent to Longview is the city of Kelso, population 9000. Kelso is primarily a residential community providing workers for the Longview industrial establishments. Pertinent statistics include:

	Longview		Kelso
Population 1950	20,385		7345
1956	23,100	(July estimate)	9000
Area		- 9 square miles	
Population Density		- 2570 persons per square mile	

TOPOGRAPHY AND CLIMATOLOGY

Longview is located on the Columbia River at a point where the river changes course from north to west in its path to the Pacific Ocean. At this same point, the Cowlitz River enters the Columbia River from the north and generally forms the eastern boundary of the town. The southerly boundary parallels the Columbia River. The intervening strip of waterfront land, one-half to one mile wide, is the industrial belt. West and south are low rolling hills ranging up to 1000 feet within a few miles. To the east the hills become progressively higher as they extend into the Cascade Range.

Longview-Kelso (Cont'd.)

X The weather Climate here is of a typical coastal the maritime type with annual rainfall of 43 inches, mild winters, and moderately high relative humidities throughout the summer. The greater part of the annual precipitation falls through the winter months when this area is swept by frequent storms from the Pacific with the heaviest amounts in November and December. The prevailing winds in the rainy season, from November through February, are predominantly from the south-southeast with velocities from averaging 7 to 10 mph. X The winds are predominantly northwest from May through July with velocities still averaging 7 to 10 mph. In the intervening periods, winds are variable with a slight predominance in the up-river or down-river directions.

POLLUTION SOURCES

Transportation - Total rail activity has not been estimated. The through traffic for the major rail lines passes via Kelso, and it is estimated that not over 300 gallons of oil are used daily by the diesel-electric units passing through Kelso. There are three coal-steam freight trains daily on this line. Most of the rail activity in Longview is by small local and company-owned railroads and it is understood that most of them operate with diesel-electric units. With the early replacement of the coal-steam units, the contribution to air pollution by rail activities will be negligible.

Shipping is quite active on the Columbia River as far as Portland. In 1955 approximately 1460 vessels of over 1000 net registered tons sailed into this area. This is somewhat less than the number of arrivals in Puget Sound. No estimate has been made of the amount of fuel burned while these ships are in the area but it has not been considered to be a significant air pollution problem.

Longview-Kelso (Cont'd.)

It has been estimated that vehicular traffic accounts for about 14,000 gallons of gasoline per average maximum day. The resulting emissions would be:

Pollutant	Tons Per Day
Hydrocarbons	2.8
Nitrogen Dioxide	0.6 - 2.2
Sulphur Dioxide	0.1

This contribution is not considered highly significant in terms of the general atmospheric pollution. The traffic pattern is such, however, that heavy concentrations of automobiles occur at the time of shift changes at industrial plants. As these traffic peaks hit the downtown area, local heavy concentrations may occur for brief periods.

Domestic, Commercial and Municipal - The space heating fuel oil requirement for Longview and Kelso residential units is estimated to be on the order of 20,000 to 24,000 gallons per day average during the 8-month heating season. The total space heating requirement including commercial is estimated to be about 1½ times this amount. It is estimated that space heating during the heating season would require about one-half the amount used by the major fuel-oil consuming industries and less than one-third on an annual basis.

The use of hogged fuel for domestic and commercial space heating is considered to be relatively small. Localized problems may result, however, from inadequate combustion control. As compared to domestic and commercial users, industry is a major user of hogged fuel as is the local steam power plant which uses either or both hogged fuel and oil.

Garbage collection is compulsory in both Longview and Kelso. Both cities operate open burning dumps for garbage and refuse. The burning dumps are located southeast of Longview, one on the east side and one on the west side of the Cowlitz River about a mile above its confluence with the Columbia River. These burning dumps are a source of smoke and odor.

Longview-Kelso (Cont'd.)

Industrial Activities - There are some 35 industrial establishments in Longview of which the major plants include:

One Kraft sulphite, pulp and paperboard plant

One Kraft pulp, paper and container board plant

One ground wood pulp plant

Two major lumber and plywood plants

One aluminum smelting plant

In addition, there are about eight smaller lumber and wood fabrication plants, several metal fabrication plants and two concrete products plants.

The primary problems that have been attributed to industrial operations in recent years include:

1. Cinder emissions from the large scale use of hogged fuel in industrial power plants.
2. Dust fall from pulp mill operations - the dust fall material includes suspected corrosive materials.
3. Sootfall from oil combustion.
4. Occasional hydrogen sulphide staining of lead base paint.

Most of the plants have controls of one type or another, although reliable data are not available as to their efficiency. Typical examples include:

1. The Kraft mills have electrostatic precipitators on the recovery furnaces, scrubbers on the lime recovery kilns and multiclones on hogged wood fuel burners.
2. The largest lumber and plywood mill uses hogged fuel exclusively for power and at the present time is installing stokers, automatic combustion controls and cinder collectors for all powerhouse boilers. In addition, cyclones are installed within the plant for the collection of dust and fine particles.

Longview-Kelso (Cont'd.)

3. Another large lumber and plywood mill purchases all of its power and is therefore not faced with the problems associated with hogged fuel or oil combustion. Cyclones for collection of fine sawdust are installed.

The problem of possible effect on livestock, vegetation and property values due to aluminum plant fluoride emissions has been the subject of considerable interest and of legal action. In 1956 the Ninth District Court of Appeals upheld a local district court finding that there was no harmful effect on livestock or property values as the result of aluminum reduction operations at Longview and Troutdale, Oregon. Currently a suit has been filed for damages by several dairy farmers in the vicinity of the Longview plant. Dust collectors and fume collecting systems normal to the industry are in use at this installation.

PREVIOUS STUDIES

One study, over a year period, was made by the University of Washington Environmental Research Laboratory and supported by industry(31). The report was of a confidential nature and the technical data developed are therefore not included here. The study covered the emissions of cinders, dust, and soot from the two pulp mills and the P.U.D. power plant and the fallout pattern under various meteorological conditions.

The Environmental Research Laboratory also conducted a brief study in connection with two episodes of paint discolorations -- one occurring in December 1954 and the other in October 1955(32) (33). Following the first incident, painted panels were set out around the city as a means of obtaining complete data should such an incident recur. Such an incident again occurred in October 1955. Due to the discontinuance of the State Air Pollution Advisory

Service, a complete analysis of the second incident was not made. Sufficient investigation was made, however, to determine the extent of the area of damage and the probable industrial source of the pollutant under the wind conditions existing at the time. It was concluded that the damage was due to emission of hydrogen sulphide and the subsequent reaction with lead base paint. Titanium base paints were not affected.

LOCAL CONTROLS AND ACTIVITIES

There is no local control program by ordinance. City officials are desirous of voluntary correction by industry when needed. Occasional complaints are received regarding cinders, soot, etc. Some 203 complaints were received in one day in connection with a paint discoloration incident. The water department receives and records the complaints. It participated actively in the paint discoloration study discussed above.

SUMMARY

Longview, with its economy based on lumber and wood products industries, is so situated in relation to the industrial area that, without adequate control, air pollution would be severe. The fact that it is not more serious attests to the fact that industry is not blind to its responsibility. Available information indicates that industry is utilizing better control devices and practices. Contributions by domestic and commercial activities are considered normal. Chronic sootfall is due both to space heating and industrial use of oil fuel while an occurrence of acute sootfall would be most likely due to malfunctioning of industrial burners using heavy oil.

VANCOUVER

GENERAL DESCRIPTION

Vancouver is an industrial city located on the north bank of the Columbia River about 80 miles upstream from the river mouth at the Pacific Ocean. It is an integral part of the Portland, Oregon metropolitan area. The greater Vancouver area population is about 65,000. Sixty-five percent of the incorporated area is developed. The estimated 1975 population is about 61,000(21) with a predicted 121,000 for the greater Vancouver area. This is based to some extent on the prediction that Vancouver will increase in importance as a sub-dominant center to Portland. Pertinent statistics include:

Population	1940 - 18,788	
	1950 - 41,664	
	1956 - 42,300	(July estimate)
Area		- 10.1 square miles
Population Density		- 4200 persons per square mile

TOPOGRAPHY AND CLIMATOLOGY

The city is located on what may have been at one time an island in the River. There is a high point of 225 feet elevation at the north city limits from which it drops sharply to the west but gradually to the south and southeast toward the River to an elevation of 25 feet. To the north and northeast are rolling hills 200 to 300 feet high. The residential development is in this direction, with industry being located along the waterfront and to the west.

Vancouver (Cont'd.)

The geographical factors surrounding Vancouver exert a major influence on climate. The shielding afforded by the Coastal Range results in a climate distinctly different from the maritime climate of the nearby coastal plain, while that afforded by the Cascades results in Vancouver's climate being equally different from the continental one of the plateaus to the east.

Winds over the area are predominantly from the west and air masses, conditioned by the Pacific Ocean, greatly moderate winter and summer temperatures. The temperature extremes that do occasionally occur are definitely linked with easterly air flow through the Columbia River Gorge giving the area a brief taste of continental climate. The hills and mountains provide some protection from high winds; the yearly average is about seven miles per hour. Northwesterly winds prevail 37 percent of the time from March through September, and southeasterly and easterly winds (from the direction of the Gorge) prevail nearly 25 percent of the time during the same period. Calms are experienced less than one percent of the time(22).

About 45 percent of the 42 inch annual rainfall occurs during the winter, while 27 percent falls in the fall and 22 percent occurs in the spring. Normally the sun shines about 50 percent of the time possible. There are long periods of comparatively clear weather in the summer with a normal maximum of 70 percent of possible sunshine in July. This decreases to a minimum of about 25 percent in December.

POLLUTION SOURCES

Transportation - Vancouver is on the main line for rail traffic going north from Portland and going westward through the Columbia River Gorge. Only three steam locomotive units pass through each day but twenty-three diesel units

Vancouver (Cont'd.)

enter and leave Vancouver on the north-south tracks and 40 diesel units traverse the east-west route daily. In addition there are seven diesel switch engines working 19 eight-hour shifts per day at the freight yards. This activity results in the combustion of approximately 1500 gallons of diesel fuel per day plus the coal for the three freight trains. All steam locomotives are scheduled to be replaced by diesel-electric units within the next 12 months. Except for the possible nuisance created by the coal-fired locomotives, it is believed that the railroads do not contribute significantly to air pollution in Vancouver.

Shipping is quite active on the Columbia River up as far as Portland. In 1955 approximately 1460 vessels of over 1000 net registered tons sailed into this area. This is somewhat less than the number of arrivals in Puget Sound. No estimate has been made of the amount of fuel burned while these ships are in the area but it is not considered to be a significant air pollution problem.

There are two main highway arterials through Vancouver comparable to the railroad routes -- the north-south U.S. 99 and the east-west U.S. 830. Total passenger vehicle miles is estimated to be about 437,000 miles for an average maximum day during which 29,000 gallons of gasoline would be consumed within the city limits. The resulting emissions would be:

Pollutant	Tons Per Day
Hydrocarbons	6
Sulphur Dioxide	less than 1
Nitrogen Dioxide	1 to 5

There would also be significant amounts of aldehydes, organic acids, acetylene and aerosols.

Domestic, Commercial and Municipal - Oil is the predominant heating fuel but natural gas is now available. It is estimated that about 12 million gallons of heating oil are burned each year in this metropolitan area. Assuming that it is all burned during the eight month heating season, the average daily consumption would be 50,000 gallons per day. The products of this combustion would include hydrocarbons, particulates, oxides of nitrogen, and sulphur.

Refuse collection is compulsory and disposal is by burning on a dump five miles east northeast of the city. There are a number of backyard incinerators which reportedly create some problems in certain areas.

Industrial Activity - Industrial activity includes:

Lumber, plywood and wood fabrication
Concrete products manufacturing
Fruit and vegetable canning
Aluminum smelting
Chemical production (aluminum sulphate, hydrogen peroxide)
Pulp and paper production (bleached sulphite)
Brewing
Meat packing

Vancouver is not heavily industrialized at the present time. Most of the industrial area is west and northwest of town. A considerable area in this direction is being developed for industrial sites. Full development will bring air pollution problems unless care is taken in the selection and control of future industries. A large part of the potential industrial area is outside of the city limits.

Pulp mill odors are apparent during the occasional periods of air stability. The local brewery in the downtown area is reported as an occasional emitter of smoke due to poor combustion of oil. Conversion to natural gas is planned at this plant.

PREVIOUS STUDIES

A study of the effect of the aluminum reduction mill on livestock and feed was made by Oregon State College and Washington State College in 1952 and 1953(34). The area studied was on Sauvie Island located across the Columbia River on the Oregon side west of the plant. The study concluded that there was no significant fluorine uptake in the forage, that the symptoms and lesions of disease in cattle were both due to causes other than fluorosis, and that the occasional fluorine contamination of the atmosphere was of low magnitude and short duration. Control equipment common to the industry is installed and maintained at the mill. Data as to its efficiency, however, have not been made available. It is expected that proper equipment and good operation can minimize any problem in the immediate vicinity.

LOCAL CONTROLS AND ACTIVITIES

There is no local air pollution control program. Occasional complaints are referred to the health department or the building department depending upon the nature of the complaint. A zoning ordinance contains provisions for manufacturing areas prohibiting the location of certain types of industries which produce obnoxious odors, smoke, etc.

SUMMARY

Air pollution in Vancouver is significant primarily as a factor associated with future industrial development and the fact that Vancouver is in the zone of influence of air pollution from the city of Portland and its environs.

ABERDEEN-HOQUIAM-COSMOPOLIS

GENERAL DESCRIPTION

These three communities situated side by side on Grays Harbor constitute the major coastal population concentration. Located near the heart of the large southwest Washington timber area, the major economy is in lumber and wood products. Fishing and fish products are the second major support to the local economy. Pertinent statistics include:

		Aberdeen	Hoquiam	Cosmopolis	
Population	1940	19,653	11,123	1164	
	1955	20,300	11,200	1245	
	1956	20,500	11,400		(July estimate)
Area		10.5	4.95 (land)		(square miles)
Population Density		1950	2300		(persons per square mile)

TOPOGRAPHY AND CLIMATOLOGY

The three cities are located at the head of Grays Harbor where the Chehalis River enters from the east and Hoquiam and Wiskah Rivers enter from the north. To the south the land rises rather sharply to over 600 feet within a few miles and continues southward into the low rolling Willapa Hills.

To the north the land rises somewhat more abruptly to over 400 feet within the city limits of Aberdeen. The land continues to rise to the north in a series of north-south hills and valleys approaching the Olympic Range. To the west the harbor is exposed to the Pacific Ocean and to the east is the Chehalis River valley forming a trough between the Olympic Range and the southerly Willapa Hills.

Except for temperature and precipitation, climatological data is very meager for this area. Temperatures are moderated by the proximity to the Pacific Ocean. This proximity together with the local topography produces relatively high rainfall. The prevailing wind is from the southwest and under storm conditions may reach quite high velocities. The development of a high pressure system in the interior together with an offshore low pressure system produces occasional easterly winds. These winds usually occur more frequently in winter than in summer. Stable air conditions might be expected to occur somewhat less frequently than in the Puget Sound area. In general winds are favorable the greater part of the time toward minimizing the accumulation of pollutants in the area. It is expected then, that air pollution problems would be primarily due to smoke and fumes carried by light winds into the residential areas, and to fallout of large particles such as cinders.

POLLUTION SOURCES

Transportation - The Grays Harbor area is served by three major rail lines providing daily freight service. The three diesel-electric switch engines and the diesel-electric freight engines are estimated to use about 300 gallons of diesel oil daily within the city limits of the three communities. This contribution is considered minor. The operation of one oil-steam switch engine, however, is likely to produce considerable smoke and soot at times. It is expected that this switch engine will be replaced with a diesel-electric unit in 1957.

It is estimated that there are not more than 200 ships annually of 1000 net registered tons and over. Unless there is a substantial number concentrated at any one time, shipping is not considered to be a consistently large contributor to air pollution. Ships laying over, however, together with those smaller vessels at home port, during periods of fire-up, may produce smoke for brief periods.

Gasoline consumption by vehicles is estimated to approximate 20,000 gallons on an average maximum day. The resulting emissions would be:

Pollutant	Tons Per Day
Hydrocarbons	4
Nitrogen Dioxide	0.8 to 3.2
Sulphur Dioxide	0.2

This is not considered to be a substantial source of air pollution.

Domestic, Commercial and Municipal - Oil is the major fuel for space heating although some wood is used. It is estimated that residential oil burners consume an average of 27,300 gallons per day during the eight-month heating season and that the total requirement for space heating, including commercial establishments, would be on the order of 50,000 gallons per day. Most of this would be light oil. With poor equipment or poor combustion, it is a source of chronic sootfall. In comparison, industry uses at least this much daily throughout the year. Combustion in industrial boilers should be efficient; but in the event of malfunctioning of the equipment, the poor combustion of heavy oil could result in heavy sootfall.

Industrial Activities - The industrial activities in the Grays Harbor area are outlined in the following table showing the approximate distribution of industry by type:

Industry	Aberdeen	Hoquiam	Cosmopolis
Sulphite Pulp and Paper		1	
Sulphite Pulp			1 (under constr.)
Plywood	3	1	
Lumber	4 large 3 small	1 large 1 small	
Shingle and Shake Mfg.	3	7	
Wood Fabrication (including Boats)	7	5	
Foundry and Heavy Equipment	3	2	
Light Steel Fabrication	2	1	
Fish Canning and Freezing	3	3	
Concrete Products	1		
Dairy Products	1	1	

Up until about two years ago, complaints were quite frequently received at the Hoquiam City Hall concerning odors and vegetation damage due to the pulp mill. It is reported that the situation is now much improved and that there have been no complaints this year. Controls at this plant include soot collectors on the boilers and cooking gas recovery for acid preparation.

The construction of the new pulp plant at Cosmopolis will bring the total pulp capacity of the community to over 700 tons per day. Waste liquor will be evaporated and burned. Multiclones will be installed on the hogged fuel boilers for cinder collection. Recovery boiler fumes will be scrubbed and passed through precipitators. Digester gases will be recovered for acid making.

With adequate mechanical controls and recovery systems the prevention of air pollution then becomes a matter of good operation and maintenance.

The primary source of fuel for power in the plywood and lumber mills is wood waste material. There is, thus, a real potential for air pollution in the form of cinders and large unburned wood particles from combustion in boilers and waste burners. There were no complaints reported and there have been no previous studies to determine the extent of this problem. There is a trend toward disposal of wood waste to the pulp mill for pulping and fuel. This practice will, no doubt, increase with the completion of the new pulp mill.

LOCAL CONTROLS AND ACTIVITIES

There is no local organized control program. Complaints have apparently not been sufficient to justify a routine procedure for receiving and investigating complaints.

SUMMARY

The major sources of potential pollution in the community include process wastes from the pulp mills and cinder emissions from the hogged fuel boilers in the pulp and lumber mills and the wood waste burners wherever they may exist. Although the meteorological factors are generally conducive to good dispersions of pollution, it is estimated that there is or can be a problem of cinder and soot fallout. Good combustion controls and a reduction in the practice of wood waste disposal by burning would be the major need. The lack of complaints would indicate that the problem is either not severe or is tolerated.

YAKIMA

Yakima has a population of 44,300 in an area of 6.7 square miles. The second largest city in eastern Washington, it is located in the heart of a large irrigated agricultural area. Its predominant industries are in food processing and lumber. Immediately to the south is the town of Union Gap with a population of 2060 and to the north is the town of Selah with a population of 2800.

The topography and climatology of Yakima are such that air pollution is becoming a potential problem as the City grows and as the number of pollution sources increase. Located in a sector of the Yakima River Valley, the City is confined to the north and to the south by high, steep hills which are pierced by the steep, narrow Selah Gap to the north and Union Gap to the south. To the west, the terrain rises irregularly toward the Cascades in a series of hills and valleys while to the east the land rises gently to high hills, 10 to 12 miles distant. Winds are predominantly light, averaging west 6.3 mph. During the summer months the prevailing wind shifts slightly to the west-northwest and northwest. Nighttime summer temperatures drop rapidly after sunset with resulting drainage of cool stable air from adjacent mountains into the lower regions. This cold air, draining into the Yakima Valley from the surrounding mountains and ridges, overflows through the passes to the east leaving behind a pool of cold air and the only path of escape for this "bottom" air is through the narrow Union Gap. Under stable conditions, the pool of cold air, somewhat over 700 feet in depth, may be expected to remain until an occasional "Chinook" from the west flushes it out.

The major smoke sources are in the cities of Yakima, Union Gap, Selah and the orchards near the airport where oil burning orchard heaters are used.(50) When the burners are in use, the entire valley floor may be obscured by dense smoke until noon.

The largest industrial operations are the seasonal canneries and freezing plants which at times are reported to discharge excessive smoke. There are three large sawmills; one is located just outside the city limits and is a heavy smoker. Two very apparent air pollution sources are the burning municipal dump southeast of the City and the burning at a private salvage dump just east of the city.

The air pollution potential at the present time in Yakima is primarily attributed to the climatological and meteorological features of the area.

WENATCHEE

Wenatchee has a population of 16,500. Its area is 3.16 square miles. Population growth estimates range up to 20,000 by 1963. Wenatchee is a commercial center serving large apple, peach, and cherry orchards. Because of the cities' location Located in a valley of the Columbia River, the topography is such that the winds there are generally deflected normally either upstream or downstream. They are normally downstream (northerly), but occasionally in the spring and fall, southerly winds ~~will~~ occur.

Oil is the predominant fuel. Soot is quite apparent on snow during the winter. Although the City operates one of the outstanding sanitary fills in the State for garbage disposal, it also maintains a small burning dump for dry refuse on the waterfront. The City also operates a small asphalt plant.

Food processing and meat packing are the major industries aside from the large cold storage plants. Railroad shops, located south of town, are generally downwind and not a problem to the City. Several miles further downstream are located two sizeable industrial installations. One is a ferro-alloys plant from which large volumes of silica-bearing fumes are emitted. The topography at this point is such that even with northerly winds, local eddies are created and the fumes can be carried upstream as far as East Wenatchee. In the same vicinity is a large aluminum smelter from which there is very little visible evidence of emissions. Modern air pollution controls common to the industry are used in this plant.

The State College of Washington Agricultural Experiment Station has for several years carried on routine examinations for vegetation damage in the area. Until recently there was no reported damage. Presently there is suspected orchard damage six miles downstream from the aluminum smelter. Confirmation of such damage, however, has not been reported.

Wenatchee (Cont'd.)

There is no local program in air pollution control at Wenatchee. Only rarely are complaints received and these are the local nuisance type. The zoning ordinance prohibits the presence of certain industries. At the present time, areas north of town are zoned for agriculture by the county. To the south toward Malaga, areas are zoned for industrial sites. This would appear to be wise planning in contrast to allowing pollution-producing industries to locate to the north of the City.

RICHLAND - PASCO - KENNEWICK

Known as the Tri-Cities, the populations of these towns are as follows: Richland 26,200; Pasco 13,900; and Kennewick 13,600. The economy of the area is based on the large Hanford atomic energy works and agriculture.

Richland is an unincorporated, government-built, residential town serving Hanford. The only problem reported at Richland was the occasional odor from the sewage treatment plant.

Pasco is a major rail freight center. It is estimated that there are over 100 diesel-electric units on freight and passenger trains daily and 144 yard hours of diesel-electric switch engine operations. In addition, there are two oil-steam freight locomotives daily. With the exception of the oil-steam freight units, the rail activities are not considered a significant source of pollutants. There have been complaints about the railroad roundhouse which is expected to be eliminated in the next few years.

At Kennewick, there has been a problem with pulp disposal from a grape juice plant. A chemical fertilizer plant, some six miles southeast of the area, has been reported as a problem at certain times. Normally the ~~prevailing~~ winds are such that emissions do not reach the Tri-City area.

The area is not heavily industrialized. It is expected that industrial development in the future will be that associated with supplying the needs and processing the products of the agricultural enterprise.

WALLA WALLA

Walla Walla has a population of 25,600. It is a major city in the southeast part of the State and is located in the heart of a large agricultural area. The major crops are grain, peas, and truck farm produce. The problems that were reported were of a nuisance type, all of which could be readily solved. The majority of the complaints were concerning an asphalt plant, a rock crushing plant, an ammonia fertilizer distribution station and a can manufacturing plant. The operators of the rock crusher were apparently making a real effort to hold down the dust. A homemade dust control device at this installation consisted of window screen material fastened on high posts over which a curtain of water was allowed to fall.

Natural gas became available to Walla Walla in the fall of 1956 and this should solve those problems of soot, fly ash, etc., associated with improper combustion of other fuels.

Winds are southerly averaging 5.6 mph and quite uniform throughout the year. High winds are infrequent due to the sheltering effect of the hills and mountains surrounding the valley. There is generally considerable valley fog from November through January during times when light winds prevail. This condition sometimes persists for several days. The light wind pattern is conducive to poor pollution dispersal. This, together with the stable air conditions in the winter months, could result in severe air pollution should a large source or sources be present.

There is no local program specifically directed at air pollution control. Complaints, however, are investigated by the health department, building department and the planning commission.

BREMERTON

Bremerton has a population of 30,100 in an area of 4.52 square miles. The estimated population in the metropolitan area is 50,000. Its major economy is based on the large Navy shipyard. Its population varies with the activity in the yard.

There are no major sources of air pollution. Heavy smoke used to issue from the shipyard stacks, but this has not been reported as a problem in recent years.

Bremerton is in the sphere of influence of air pollution from Seattle and Tacoma, the local effect being in the form of reduced visibility and hours of sunshine.

RENTON

Renton, with a population of 16,000, is located at the south end of Lake Washington and lies in the Green River Valley-Lake Washington trough.

Although there is not a large number of industries here, there are two very major installations. One is an aircraft manufacturing plant and the other is a heavy machinery manufacturing plant. Although the industrial processes at these plants have not created a problem, they both burn large amounts of trash, packing cases, etc. One uses ordinary open burning and the other uses a beehive type burner.

Other problems include dust and smoke emissions from an asphalt plant, dust from a brick plant and from a sand and gravel plant, and odors from a creosote plant several miles down-lake from Renton.

Air pollution in Renton is not severe at the present time. The proposed industrial development in the lower Green River Valley area, however, poses a potential problem to Renton. Renton has a new zoning ordinance with strong provisions for air pollution control.

PUYALLUP

Puyallup has a population of 11,000 people. It is primarily a commercial and residential community. Other than one lumber mill and one concrete products plant, the entire industrial activity is based on fruit canning and packing. There is an occasional smoke problem from the packing plant reported as minor during the seasonal operation.

Puyallup is affected by atmospheric pollution from Tacoma. Pulp mill odors from Tacoma reach the town during periods of light westerly winds. It is interesting to note that in 1891 the city of Puyallup passed an ordinance prohibiting the then common practice of hanging freshly caught salmon on the stalks of hop vines for fertilizing purposes. Apparently this was a real odor problem at the time. The ordinance, no longer needed, has been revoked. This was probably one of the earliest pieces of air pollution legislation in the State.

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SECTION TWO

Part IV

SELECTED COMMUNITIES OF 4,000 - 10,000 POPULATION

The following communities, having a significant degree or potential of air pollution, are discussed in summary form.

Anacortes

Camas

Clarkston

Port Townsend

Shelton

These additional communities are included because of local interest or a history of air pollution problems:

Auburn

Ellensburg

Sunnyside

Toppenish

ANACORTES

Anacortes has a population of 8200. Its area is 7.3 square miles of which only about 4 are occupied. It is located on Fidalgo Island east of Rosario Strait.

Its principal industries include a sulphite pulp mill, 4 fish canneries, a plywood mill, and a shingle mill. There has been no problem from the canneries. There is smoke from the plywood and shingle mills. The most likely source of air pollution is the pulp mill. Several miles southeast of Anacortes on March Point is the State's largest oil refinery. Another large refinery is projected for this same location.

The summer winds are northwest while the winter winds are southeast. The wind pattern is such that only rarely are emissions carried into town. The heavy industry area is to the east of town while most of the fish canneries are to the northwest. The summer northwest winds carry the pulp mill emissions away from town. The winter southeast winds are usually of such velocities to provide adequate diffusion. Occasionally, during periods of calm stable air, the pulp mill emissions will drift into the business and residential areas. In years passed, occurrences of lead base paint damage have been reported. This has not been reported in recent years particularly since the plant converted to an ammonia base.

The canneries have not been a problem. No problem has been reported in connection with the operation of the oil refinery.

There is no local air pollution control program. The relatively few complaints have not justified a program or study. In summary, although there are potentially severe air pollution sources, the local meteorology is favorable to the city. Should areas to the west of the city become sites for industries which are a source of pollution, there could be a problem - particularly in the summer months.

CAMAS

Camas has a population of 5200 in an area of 3.5 square miles. It is located on the Columbia River, upstream from Vancouver and just downstream from the lower extremity of the Columbia River Gorge.

Camas is an example of a small community with one very large industry. Located almost at the heart of the City is one of the State's largest sulphite and sulphate pulp mills. Problems in past years have included paint discoloration, metal corrosion and white chalky deposits. The number of complaints and the amount of damage are apparently continually diminishing. This would indicate improved controls and operating practices at the plant. Controls in use are common to the industry in this State. Typical of the industry, oil has been used as fuel in tremendous quantities. Some 60 per cent of this fuel requirement will be met in the future with natural gas which should reduce the probability of sootfall problems.

There is no local air pollution control program or activity in this community.

CLARKSTON

Clarkston, with a population of 6400, is located at the eastern border of the State across the Snake River from Lewiston, Idaho. This is an example of a severe out-of-state source of air pollution.

Clarkston is located in the deep canyon of the Snake River at an elevation of 750 feet. The Snake River approaches from the south and leaves on a westerly course. At this point, the Clearwater River enters from the east. To the north the land rises to nearly 3000 feet elevation in a few miles. To the south the slope is more gentle, rising to less than 2000 feet in the same distance.

About two miles east of Clarkston, in the city of Lewiston, Idaho, is a large pulp plant. The prevailing winds are easterly and they are generally light. Occasional strong winds are westerly. ~~On~~ approaching ~~Clarkston~~ from the west in September the pulp mill odor was easily detectable ~~at a distance~~ of 15 miles. It is reported that the pulp mill odor it occasionally reaches Pomeroy, thirty miles to the west. Under some conditions, the odor can be detected over the high ridge to the north as far as Pullman. Stable air frequently occurs at night and into the mid-morning. Fog, most frequent in November, December and January is the result of radiation cooling, and due to cold air drainage into the valley, often forms below the elevation of the airport (elevation 1400 feet). Smoke from the plant usually flows westward down to the Clearwater River valley and into the Snake River valley. Local information, not confirmed, is that people of Clarkston are moving to higher elevations to the southwest in order to avoid the odor.

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There have been no previous studies nor is there a local air pollution control program. Air pollution control is embodied in the zoning ordinance but it is ineffective for the major out-of-state source.

PORT TOWNSEND

Port Townsend is located on the Strait of Juan de Fuca at the entrance to Puget Sound. It has a population of 4600 and an area of 6.5 square miles. Much of the area is sparsely settled. There is one large sulphate pulp mill located two miles south of town. There is no other major industry.

The topography and climatology are such that the emissions from the pulp mill seldom reach the downtown area. The prevailing winds are from the northwest. Winter winds are from the southeast. With northwest winds the emissions are carried away from the town. With southwest winds the emissions are carried over the hill on the peninsula to the south of town. Odors and paint discoloration have been reported. Controls at the plant include scrubbers and electrostatic precipitators on the smelters, scrubbers on the lime kilns, and a digester recovery system. Improvements are planned for increased recovery from smelters.

Perhaps the most significant effect of this operation is its contribution to the general atmosphere over the Hood Canal and Puget Sound areas. Observations made during July 1956, under temperature inversion condition, distinctly showed the emissions to be carrying in a southerly direction for some 25 miles or more.

Burning is practiced at the municipal garbage dump, remotely located five miles west of town.

There is no local program or activity in air pollution control. There have been no previous studies, and complaints are rare.

SHELTON

Shelton has a population of 5700 in an area of 3.5 square miles. It is located on Hammersley's Inlet in the southwest area of Puget Sound. The city lies in a small valley about one mile wide with hills rising abruptly to over 250 feet on both the north and south side. Its easterly exposure is to the Inlet, and the valley to the west becomes very narrow.

The major industry is in wood products and includes a sulphite pulp mill, 2 sawmills, one fibreboard plant, one shingle mill, and one plywood mill. All but one of these plants are located on the waterfront on the easterly margin of town.

The primary problem here is the pulp mill. The mill is characterized by a tall stack over 500 feet above sea level from which steam and combustion gases from the burning of waste sulphite liquor are emitted. Although this stack is tall enough to afford good diffusion most of the time, observations indicate that the plume strikes the hill area south of town and settles in the narrow valley west of the town occasionally. Under conditions of air stability and/or light winds, SO_2 emissions from the main plant occasionally settle over the town and are quite pronounced. The major control here is the return of SO_2 to the acid plant. The prevailing winds are westerly and southwesterly. Occasional winds during the summer months are experienced from the northeast and east northeast.

Other industrial activities were not reported as being particular problems.

Other than the normal domestic and commercial activities, the only other source is the community burning dump, which due to its remote location, is a minor air pollution problem.

There are no local controls or air pollution activities. There have been no previous studies.

AUBURN

Auburn, with a population of 7600 and an area of 2.1 square miles, is located in the Green River Valley between Seattle and Tacoma. Its population is expected to increase to 10,000 by 1958.

The city is a particularly active railroad center. It is estimated that there are nearly 100 diesel-electric units on freight and passenger trains passing through daily. In addition, there are 11 diesel-electric switch engines operating a total of approximately 264 hours daily and one coal-steam switch engine operating 8 hours daily and 15 coal-steam freight engines passing through daily. This would account for some 2300 gallons of diesel oil daily plus the coal for the switch and freight engines. Three days of heavy oil sootfall were reported last winter. This would indicate either serious malfunctioning of diesel-electric equipment or that oil-steam units were operating at the time. Rail activity has been the most serious problem. The expected changeover to diesel-electric units in 1957 should considerably minimize this source.

There is only light industry at the present time. The city, however, is anxious to attract industry on a selective basis and proper site location. The valley location and the accompanying climatological factors are such that air pollution can be very serious here if the sources were present. Auburn is exposed to air pollution from Tacoma and Seattle during periods of light winds and stable air conditions. The effect is primarily odor and reduced visibility.

ELLENSBURG

Ellensburg, with a population of 6200, is located in the upper Yakima River cattle country. Lumber and food processing are also major industries.

Here is an example of a public institution creating a local problem. Coal is burned in the heating plant for the Central Washington College of Education. Normally during the winter with efficient combustion, the problem is minor. In the summer, however, operating at reduced load and low efficiency, heavy emissions of flyash and soot occur. This problem was studied by Kusian and Pate in 1954(35). They noted that "soot deposits on porches and lawns of numerous residences were so heavy that one could not sit down without being coated with it. Trees and shrubs showed some discoloration on the side toward the plant. Evidence of rapid discoloration of the new paint was noted." They pointed out that coal can be burned efficiently and cleanly with proper methods. They made certain recommendations regarding mechanical changes and operating procedures. It is understood that natural gas will be used in the future for summertime operation.

Located at the foot of the eastern slope of the Cascade Range, Ellensburg has prevailing northwest winds averaging 15 miles per hour from March to October and resulting good dispersion of pollutants most of that time. After October, wind velocities drop abruptly, with frequent periods of near calm weather lasting for days at a time. Thus, during the four winter months, the meteorological conditions are favorable for atmospheric accumulation of pollutants.

There is a local smoke ordinance but it has not been considered by the city to be of too much practical use.

SUNNYSIDE

Sunnyside has a population of 5900. It is located in the lower Yakima Valley and its major industries are dairy products and food processing.

There are no significant air pollution problems reported at the present time. Sunnyside has an ordinance prohibiting the maintenance of smoke nuisances. This ordinance was adopted in 1944 when soot and flyash were a problem from one particular plant in town. The ordinance was apparently adequate to solve the particular problem and to prevent the subsequent development of such problems.

TOPPENISH

Toppenish has a population of 6000. It is located in the Yakima Valley and it has one large industry, a beet sugar plant, in addition to several smaller industries including food processing. The only problem reported was smoke, soot and flyash from the combustion of coal at the beet sugar plant. In the fall of 1956, the company converted from coal to natural gas and it is expected that this problem has thereby been solved.

SECTION TWO

PART V

SELECTED SMALL COMMUNITIES WITH SIGNIFICANT AIR POLLUTION

The discussion of the following towns illustrates the type of problems that may be found in small industrial and non-industrial communities.

- Chewelah
- Colfax
- Concrete
- Dayton
- Kettle Falls
- Metaline Falls
- Quincy

CHEWELAH

Chewelah, with a population of 1690, is located in a broad valley running generally north and south and bounded east and west by irregular hills. The prevailing wind direction is from the south. There are three major operations here involving air pollution problems. One is a magnesite mining and production plant which has reduced its emissions considerably with the installation of polyclones and electrostatic precipitators. A plant producing marble chips is reported as having a dust problem. The other company produces silica in various sizes and reportedly poses a dust problem.

COLFAX

Colfax, with a population of 3100, is located near the eastern border of the State in a narrow deep valley of the Palouse River. The primary source of air pollution here is the municipal burning dump from which rather severe smoke and odor problems develop during the evening stable air conditions.

CONCRETE

Concrete, with a population of 921, is located on the Skagit River in the foothills of the Cascades.

The primary problem here involves the cement manufacturing plant. The town is located in a narrow blind valley which places a pronounced limitation on air movement, and the plant is located in the town. The problem of cement dust emissions was quite severe in the past years. There has been a notable improvement in recent years with operational practices and controls, including baghouse and cyclone collectors for the dust. The plant uses coal for fuel, and the fly ash is collected for use in the product. The emissions of sulphurous compounds from coal combustion, however, is quite noticeable.

There is a veneer and lumber plant at Concrete which is electrically equipped. Waste wood chips are sold to a pulp mill; thus, there is no problem from this source.

DAYTON

Dayton, with a population of 3000, is in an agricultural area; the major products being grain, peas and asparagus, apples, berries, and livestock.

It is an example of a small community with several local, nuisance-type, air pollution problems which need ~~not~~ among other pollutants, exist. Located in a narrow valley, the ~~topography and climatology are such~~ community will be subjected to the smoke and odors of the burning dump and a sawmill waste burner when stable meteorological conditions prevail. This condition was observed at the time of the visit by one of the authors of this report. ~~that the effect on dispersion is readily evident. For example, as observed, a stable air condition on a late afternoon in the fall permitted the~~ accumulation of excessive smoke and odor from ~~the~~ community burning dump and one sawmill waste burner. These two sources, under the condition, were sufficient to develop a well defined layer of smoke over the community.

KETTLE FALLS

Kettle Falls, with a population of 867, is located on the Columbia River in northeast Washington. Three lumber companies are close to town and burn wood wastes. One company in particular has been a problem with the emission of large particles of burned and unburned sawdust on nearby properties.

METALINE FALLS

Metaline Falls is a small community with a population of 536. It is located at the bottom of a deep Y-shaped valley along the Pend Oreille River at the intersection with Sullivan Creek. There is a large cement manufacturing plant here which in years passed had been reported as a severe problem. In more recent years, the condition has been reported as very much improved. Cyclone collectors followed by electrostatic precipitators are used for dust collection. There was only a small quantity of dust observed being discharged during full operation. The dust not re-used in the system is hauled away to a waste dump. Low grade coal is used as fuel and the odor of sulphurous compounds was evident. This company has gone to great lengths to cope with the problem aggravated by the severe topographical and meteorological conditions.

Two or three miles northeast of this town are two lead and zinc mines producing a total of about 3000 tons daily. Wet milling and flotation are used to prepare concentrates which are shipped out of the State for smelting. Typical of most of the mining in the northeast corner of the State, smelting is done at other locations and does not present a local air pollution problem.

QUINCY

Quincy, with a population of 3000, is located in the fast growing Columbia Basin irrigation area. Of particular importance here is the problem of heavy dust emissions from the operations of a diatomaceous earth processing plant. It has been the source of much concern and many complaints. The silicon ~~silica~~ dioxide dust settles in heavy amounts on and sifts into nearby buildings. There is a need here for an investigation of the possible health problem involving both the plant workers and persons nearby.

With large areas of new land being opened up for agricultural purposes, Quincy is also exposed to considerable wind-blown dust during the dry season.

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APENDIX

Statement of objective and scope of study

Questionnaire forms with transmittal letters

Interview form

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STATE OF WASHINGTON
DEPARTMENT OF HEALTH

STATEMENT OF THE OBJECTIVE AND SCOPE OF A STUDY OF THE AIR POLLUTION PROBLEM IN THE STATE OF WASHINGTON

The State of Washington, through the Department of Health, is making a study of the air pollution problem in our state in co-operation with the U. S. Public Health Service. This has been made possible through an emergency appropriation by Governor Langlie and a Congressional appropriation for air pollution research and investigation by the U. S. Public Health Service. The U. S. Public Health Service will establish research grants for study of specific problems and will aid states in appraising their particular situation by furnishing personnel for co-operative study when so requested by the State. Washington is the second state to undertake such a study, Connecticut being the first.

The objective of this study will be to investigate the status of air pollution in Washington and to supply, insofar as possible, data from which the need and scope of future air pollution program activity on a state or local basis can be determined.

The scope of the study will be to assess the present and potential state problem and to delineate specific problem areas, present and future, through a study of population distribution and trend, geography and topography, meteorology and climatology, and existing and potential sources of pollution. In addition, a determination will be made of available resources in the state for research, investigation and technical assistance in air pollution problems.

The sources of pollution, which will be considered, will include transportation, domestic activities, agricultural practices, industrial activities, refuse disposal, out of state sources and natural sources.

A summary report will be available at the conclusion of the study.

WSDH:AP
7/56

ARTHUR B. LANGLIE
GOVERNOR

BERNARD BUCOVE, M.D., D.P.H.
DIRECTOR

SECTIONS:
SANITARY ENGINEERING
ENVIRONMENTAL SANITATION

STATE OF WASHINGTON

DEPARTMENT OF HEALTH
DIVISION OF
ENGINEERING AND SANITATION
SMITH TOWER
SEATTLE 4

July 23, 1956

Honorable Mayor
Cities and Towns
State of Washington

Subject: Air Pollution

Dear Sir:

There has been considerable interest shown over the past few years regarding present and potential air pollution problems. The attached Health Department "statement" explains a study now underway, the purpose of which is to bring into better perspective the actual situation on a state-wide and local or regional basis. It is a fact-finding study and, as indicated in the "statement", will provide a foundation for the determination of the need for and type of future activity.

Your knowledge and information about your area can be most helpful. Accordingly, we are asking that you return the attached "Air Pollution Survey Questionnaire". This will assist in making a preliminary state-wide appraisal and will call attention to problem areas requiring more specific studies. It is proposed to visit local officials as time permits, to review the problems in more detail; however, your immediate return of the questionnaire will be most helpful.

A similar questionnaire is being sent to health officers, however, your appraisal of the problem is desired. You may wish to select someone such as your manager, engineer, or superintendent to complete the questionnaire.

Your interest and co-operation will be greatly appreciated.

Yours very truly,

R. L. Stockman
ROBERT L. STOCKMAN
Engineer in Charge
Air Pollution Program

RLS:mm

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STATE OF WASHINGTON
DEPARTMENT OF HEALTH

MEMORANDUM

July 23, 1956

TO: All County and District Health Officers and City Health Officers of Everett, Aberdeen, Richland and Spokane.

FROM: Dr. H. Grant Skinner, Chief, Division of Local Health Services

SUBJECT: Air Pollution Program

The State Department of Health in co-operation with the U. S. Public Health Service is conducting a survey of air pollution factors and potentials in this state. In order to conduct this survey and participate with the U. S. Public Health Service, Governor Langlie has made an emergency appropriation. We are thus able to take advantage of the personnel and facilities of the U. S. Public Health Service made possible by Congressional appropriation for air pollution investigation and research. The U. S. Public Health Service has sent to us Doctor E. R. Hendrickson, Professor of Sanitary Engineering from the University of Florida and Mr. Donald M. Keagy from the Robert A. Taft Sanitary Engineering Center at Cincinnati. Mr. Robert L. Stockman, Sanitary Engineer with this Department will participate on our behalf.

Specifically, the initial survey during the time the U. S. Public Health Service personnel are with us, will be an appraisal of the meteorological, geographical and topographical features as they influence air pollution, sources of pollution including transportation, heating, agricultural practices, refuse disposal, industry and natural sources, together with a study of local or regional areas of air pollution and existing controls and practices. Following a completion of the study report, we will be in a better position to judge the need for and the type and extent of an established air pollution program and the most appropriate means of its administration.

You can be most helpful to us with information that you have on local situations and records of complaints. Accordingly, we are asking that you complete the attached questionnaire for the area of your jurisdiction. This will assist us in making a preliminary state-wide appraisal and will call our attention to problem areas requiring more specific studies. It is planned that each local health officer will be visited for a more detailed review of the problem; however, your early return of the questionnaire would be most helpful to us in program planning.

Your interest and co-operation will be sincerely appreciated.

WSDH:AP
7/23/56

STATE OF WASHINGTON DEPARTMENT OF HEALTH
AIR POLLUTION SURVEY QUESTIONNAIRE

July 23, 1956

Please check the appropriate box and provide information for any YES answer briefly on the reverse side or attached sheet.

	YES	NO
1. Are there *any* operations (municipal, domestic, industrial) in or near your area of jurisdiction that emit noticeable amounts of smoke, fumes, dust, or odor to the atmosphere?	☐	☐
2. In your opinion, are the smoke or other pollutants in sufficient concentration to cause:		
a. Measurable discomfort or inconvenience to residents?	☐	☐
b. Damage to property? (autos, paint, clothing, buildings, etc.)	☐	☐
c. Damage to vegetation? (lawns, crops, flowers, etc.)	☐	☐
3. Have you received complaints of air pollution in which the complainant claims:		
a. Noticeable discomfort or inconvenience?	☐	☐
b. Damage to property?	☐	☐
c. Damage to vegetation?	☐	☐
4. Do any of the problems result from seasonal activities?	☐	☐
5. Are any of the problems the result of seasonal or periodic weather conditions?	☐	☐
6. Are there any local ordinances or regulations for the control of smoke, fumes, dust and odor?	☐	☐
7. Do you know of any activities planned for the future in your area which might contribute to air pollution?	☐	☐
8. Have any steps been taken to assess the local air pollution situation such as surveys, inspections, or investigation of complaints?	☐	☐
9. Are there any other groups (official or unofficial) in your community who might furnish additional information regarding air pollution problems?	☐	☐

Name of individual reporting ______________________________

Name of (fill in one)
City ____________________
County ____________________
District ____________________

Return to: Washington State Health Department, Engineering Division,
Smith Tower, Seattle 4, Washington.

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ARTHUR B. LANGLIE
GOVERNOR

BERNARD BUCOVE, M.D., D.P.H.
DIRECTOR

SECTIONS:
SANITARY ENGINEERING
ENVIRONMENTAL SANITATION

STATE OF WASHINGTON

DEPARTMENT OF HEALTH
DIVISION OF
ENGINEERING AND SANITATION
SMITH TOWER
SEATTLE 4

September 10, 1956

To The Management
Manufacturing and Process Industries
State of Washington

Subject: Air Pollution

Dear Sir:

There has been considerable interest shown over the past few years regarding present and potential air pollution problems. The attached Health Department "Statement" explains a study now underway, the purpose of which is to bring into better perspective the actual situation on a state-wide and local or regional basis. It is a fact-finding study and, as indicated in the "Statement", will provide a foundation for the determination of the need for and type of future activity.

Your knowledge and information about your own particular installation can be most helpful and is most essential to us. Accurate industry information is needed so that this source may be placed in its proper perspective in relation to other sources including transportation, domestic activity, agricultural practices, refuse disposal, natural sources, etc. The attached "Industrial Questionnaire" is designed to obtain general information by areas and communities as to types and sizes of industries and the control activities already accomplished. The information obtained will not be reported in detail nor referenced to a specific industrial installation by name.

We urgently request your co-operation in completing the questionnaire and returning it at your earliest convenience. Please feel free to supply such additional information or comments as you may desire.

Your interest and co-operation will be greatly appreciated.

Yours very truly,

R. L. Stockman

ROBERT L. STOCKMAN
Engineer in Charge
Air Pollution Program

RLS:mm

AIR POLLUTION SURVEY

INDUSTRIAL QUESTIONNAIRE

September, 1956

1. Type of Manufacturing ______________________________

2. Major Products

Major Products	Average Daily Production	Days/Year

3. Fuel Consumption:

Type	Daily Fuel Consumption

4. Raw Materials Used:

Type	Average Daily Use

5. Indicate types and amounts (if known) of process wastes (e.g., chemical, solid, gaseous, sawdust, etc.) and methods of disposal.

6. What steps are being taken to prevent the discharge of materials into the atmosphere (such as dusts, fumes, gases, mists, odors, smoke, fly ash, soot or vapors)?

7. Are there any future plans for changes in production quantities or processes, waste recovery or other that would change any of the above?

8. Describe general location of plant in relation to nearest community.

Examples: 2 miles N.W. of ______________ town on __________ river.
or south industrial area in Seattle.
or Wapato waterway in Tacoma.

Name of Firm ______________________________

Address ______________________________

Please Return to: Washington State Health Department, Engineering Division,
Smith Tower, Seattle 4, Washington

AIR POLLUTION SURVEY
WASHINGTON STATE DEPARTMENT OF HEALTH
1956

Town ____________________

Persons Interviewed ____________

____

Date ____________________

I. Town Description:

A. Population (April 1, 1956) ________ Predicted population (   ) ____

B. Area (April 1, 1956) ____________ sq. miles.

C. Density of population ____________ persons / sq. mile.

D. Directions of growth:

1. Residential ____________________________

2. Industrial ____________________________

E. Predominant industries ____________ ____________

F. Topography ____________________________

G. Total labor force (   ) ____ No. mfg. employees ____________

H. Climatology ____________________________

II. Remedial Action:

A. Legal Controls

1. Air Pollution Control Ordinance: Yes ________ No ________

2. Anti Smoke Ordinance: Yes ________ No ________

3. Air Pollution Control Provisions in:

a. Zoning Ordinance: Yes _____ No _____ Not examined _______
b. Heating Ordinance: Yes _____ No _____ Not examined _______
c. Incinerator Ordinance: Yes _____ No _____ Not examined _______
d. Nuisance Regulations: Yes _____ No _____ Not examined _______
e. Building Code: Yes _____ No _____ Not examined _______
f. Pollen Control: Yes _____ No _____ Not examined _______

B. Activity

1. Studies or surveys: Date __________ by __________ __________

2. Complaints received: No./yr. __________ since __________

3. Problems investigated by: H.D., F.D., B.D., other ______ none ____

4. Problems investigated by S.H.D. ____________________

5. Time on air pollution: man months/year __________ since __________

6. Focal point for information ____________________
(organization, agency, or individual)

III. PROBLEM EVALUATION:

Predominant fuel for Household ______________, Commercial ______________, Industrial ______________

SOURCE OF POLLUTION	TYPE	NO. S / P	SEVERITY		NATURE OF POLLUTION				REMARKS (Fuels used, existing control devices, sources in other communities.)
			Maj.	Min.	Smoke	Dust	Odor	Fume	
1. Private Home		/							
2. Apartments		/							
3. Hotels		/							
4. Office Bldgs.		/							
5. Commercial									
6. Bakeries		/							
7. Laundries		/							
8. Cleaners		/							
9. Schools		/							
10. Hospitals		/							
11. Incinerators		/							
12. Dumps		/							
13. Vehicle exhaust		/							
14. Railroads		/							
15. Shipping		/							
16. Utilities		/							

III. PROBLEM EVALUATION:

SOURCE OF POLLUTION	TYPE	NO.	SEVERITY		NATURE OF POLLUTION				REMARKS (Fuels used, existing control devices, sources in other communities.)
		S / P	Maj.	Min.	Smoke	Dust	Odor	Fume	
INDUSTRIAL:									
17. Breweries									
18. Canning & Freezing									
19. Cement									
20. Chemical									
21. Drugs									
22. Dairy Products									
23. Fertilizer									
24. Fish Processing									
25. Lumber & Millwork									
26. Meat Packing									
Metal									
27. Fabricating									
28. Smelting									
29. Milling									
30. Mining									
31. Pulp & Paper									
32. Refineries									

III. PROBLEM EVALUATION:

SOURCE OF POLLUTION	TYPE	NO.	SEVERITY		NATURE OF POLLUTION				REMARKS (Fuels used, existing control devices, sources in other communities.)
		S/P	Maj.	Min.	Smoke	Dust	Odor	Fume	
33. Stone, clay, glass									
34. Misc.									
AGRICULTURAL									
GENERAL IMPRESSIONS									